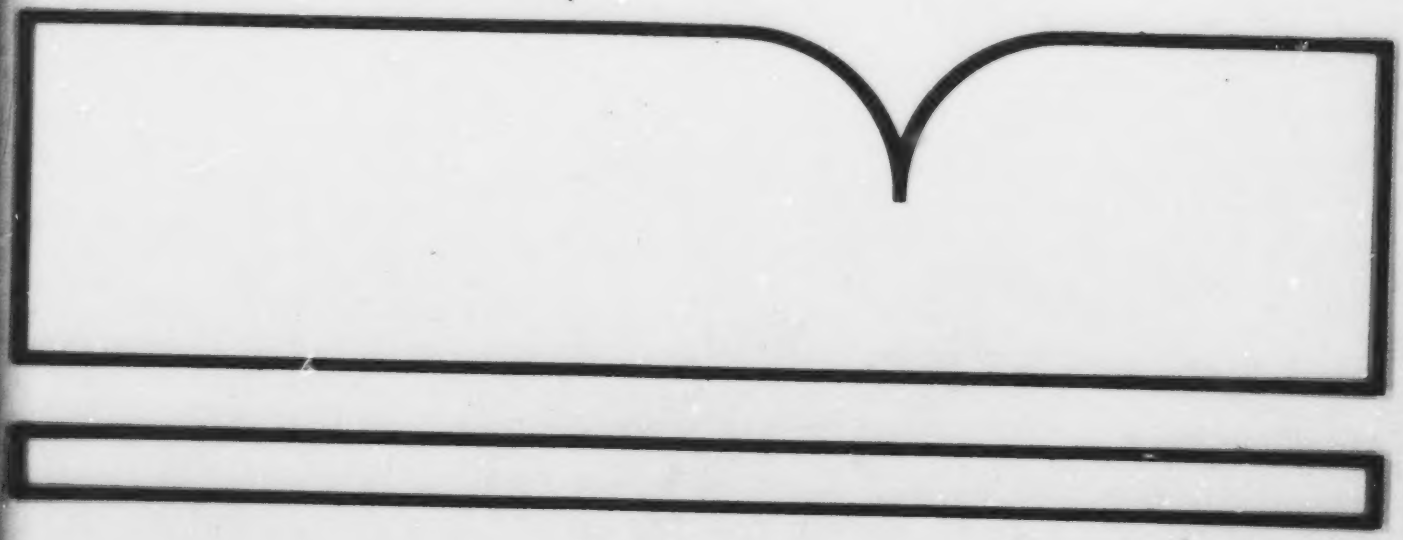
PB85-213726

Superfund Record of Decision (EPA Region 2)
Lone Pine Landfill
Freehold, New Jersey, September 1984

(U.S.) Environmental Protection Agency
Washington, DC

24 Sep 84



U.S. Department of Commerce
National Technical Information Service
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United States
Environmental Protection
Agency

Office of
Emergency and
Remedial Response

EPA/ROD/R02-84/007
September 1984

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EPA

Superfund Record of Decision:

Lone Pine Landfill, NJ

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16. ABSTRACT

The 45-acre Lone Pine Landfill is situated on a 144-acre wooded parcel owned by the Lone Pine Corporation in Freehold Township, Monmouth County, New Jersey. The landfill is approximately 500 feet south of the headwaters of the Manasquan River and 1,000 feet south of the Turkey Swamp Fish and Wildlife Management area. The Lone Pine Landfill operated from 1959 until 1979 when it was ordered closed by the New Jersey Department of Environmental Protection. While it was open, wastes accepted at the landfill included municipal refuse and septage wastes, at least 17,000 drums and several million gallons of bulk liquid chemicals. The major class of contaminants being released from the landfill are volatile organic compounds, notably benzene, chlorobenzene, methyl chloride, toluene and vinyl chloride.

The cost-effective remedial alternative which was selected for this site includes installation of a slurry wall, approximately 30 feet through the Vincentown aquifer; a multi-layer surface seal over the 45-acre landfill; installation of ground water collection wells located within the contained zone; treatment of ground water collected from within the contained zone; and monitoring to determine the effectiveness of the remedy. The estimated present worth capital cost for this remedy is $10,642,050 and the annual O&M costs are $324,734.

(Key Words on attached page)

17. KEY WORDS AND DOCUMENT ANALYSIS		
a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Record of Decision: Lone Pine Landfill, NJ Contaminated media: gw, sw, soil Key contaminants: VOCs, solvents, resins, pesticides, metals		
18. DISTRIBUTION STATEMENT	19. SECURITY CLASS (This Report) None	21. NO. OF PAGES 62
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Record of Decision
Remedial Alternative Selection

Site:

Lone Pine Landfill site, Freehold Township, New Jersey.

Documents Reviewed:

I am basing my decision primarily on the following documents describing the analysis of the cost-effectiveness of remedial alternatives at the Lone Pine Landfill site:

- Geophysical Investigation for Buried Drums at the Lone Pine Landfill, Technos, Inc., August 1981.
- Lone Pine Landfill Final Report Excavation and Sampling Fred C. Hart, January 1982.
- Lone Pine Landfill Hydrogeological Investigation, Fred C. Hart, April 1982.
- Lone Pine Landfill Preliminary Aquifer Testing, Fred C. Hart, July 1982.
- Lone Pine Landfill Analytical Results for Samples Collected September 1982, Camp Dresser and McKee, February 1983.
- Draft Feasibility Study - Lone Pine Landfill, Camp Dresser and McKee, June 1983.
- Draft Environmental Information Document for Remedial Actions at the Lone Pine Landfill, Camp Dresser and McKee, June 1983.
- Summary of Organic Chemical Concentrations in Water and Sediment Samples, Camp Dresser and McKee, August 1983.
- Evaluation of Analytical Chemical Data from Lone Pine Landfill, NUS Corporation, September 1983.
- Evaluation of Analytical Chemical Data from Lone Pine Landfill, NUS Corporation, February 1984.
- Presentation of Analytical Chemical Data and Groundwater Evaluations from Lone Pine Landfill, NUS Corporation, March and May 1984.

- Supplemental Feasibility Study for the Lone Pine Landfill Site, Camp Dresser and McKee, May 1984.

- Lone Pine Landfill Air Investigation Report, Camp Dresser and McKee, September 1984.

- Responsiveness Summary, including documents prepared and presented by the Generators Steering Committee, Freehold Township, Howell Township, and Monmouth County (see Attachment 5).

- Staff summaries, memoranda, letters, and recommendations.

- Summary of Remedial Action Alternative Selection - Lone Pine Landfill.

Description of Selected Remedy:

- Installation of a shallow groundwater cut-off wall and surface seal over the 45-acre landfill.

- Installation of groundwater collection wells located within the contained zone.

- Treatment of the groundwater collected from within the groundwater cut-off wall and discharge to the Manasquan or Metedeconk River, or alternately, to a sanitary sewer interceptor for treatment at the Ocean County wastewater treatment plant. (The specific treatment scheme will be designated upon completion of the ongoing treatability studies.)

Declarations:

Consistent with the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA), and the National Contingency Plan (40 CFR Part 300), I have determined that the selected containment and treatment strategy for the Lone Pine Landfill site is a cost-effective remedy, and that it effectively mitigates and minimizes existing and potential damage to, and provides adequate protection of public health, welfare and the environment.

I have also determined that the action being taken is appropriate when balanced against the availability of Trust Fund monies for use at other sites.

The action will require future operation and maintenance activities to ensure the continued effectiveness of the remedy. These activities will be considered part of the approved action and eligible for Trust Fund monies for a period of one year.

...
///

EPA will undertake an additional field investigation to further delineate the extent of off-site groundwater contamination. If additional remedial action is determined to be necessary to address off-site contamination, a supplemental Record of Decision will be prepared for approval of the additional action. Also, a treatability study has been initiated to study groundwater treatment methods. The results of this treatability study will be incorporated into the design phase of the remedial project.

The Region has consulted with the State of New Jersey in selecting the recommended remedial action for this site. The State concurs that containment is the most appropriate source control measure for the Lone Pine Landfill.

9/28/84
Date

Lee M. Thomas
Assistant Administrator
Office of Solid Waste and Emergency Response

NOTE:

The original feasibility study evaluated nine alternatives that addressed both source control and off-site plume control. And the supplemental feasibility study evaluated five additional alternatives. Because of the need to perform additional field investigation to further evaluate the plume, this Record of Decision (ROD) only addresses the nine source control remedial alternatives from both studies. Upon completion of the additional field ivestigation, if plume control is determined to be necessary, a supplemental ROD will be prepared. Because of the alterations in the original presentation in the feasibility study, the alternative numbering sequence has been changed as follows:

ALTERNATIVE NO.

Current	Previous
1	1 (no action)
2	4A
3	4
4	3B
5	2A
6	5
7	6A
8	6C
9	7

Briefing for the Assistant Administrator
Record of Decision
Lone Pine Landfill

Purpose:

The purpose of this Record of Decision is to select the appropriate remedial actions for the Lone Pine Landfill site that are consistent with the requirements of CERCLA and the NCP. The Assistant Administrator has been delegated the authority for that approval.

Issues:

° There has been strong public and congressional sentiment expressed towards excavating the drums disposed of in the landfill even though the feasibility study ruled out excavation because of technical and safety concerns. Furthermore, the public has asked that EPA consider research and development efforts to reduce the hazard within the site by the elimination of contaminants through state of the art technology.

° A Generators Steering Committee has been organized to negotiate with EPA. Currently, at least eight generators are participating. The Committee has provided a considerable number of comments on the draft study and has provided data representing their own field investigation. The Committee has verbally offered to cap the landfill and provide additional source control measures in the future should the cap alone prove to be ineffective. However, at this time, no formal offer, plan or supporting documentation has been provided to EPA.

° In light of questions raised about the extent of off-site groundwater contamination, it will be necessary to perform an additional off-site hydrogeological investigation. Upon completion of the proposed investigation, if off-site plume control is determined to be necessary, a supplemental ROD will be prepared for approval of the additional remedial action.

Main Points:

° The 45-acre Lone Pine Landfill operated for about 20 years ending in the late 1970's. During that time, along with municipal refuse and septage wastes, over 17,000 drums containing chemical wastes and several million gallons of bulk liquid chemical wastes were disposed of in the landfill. Hazardous substances continue to be present at the landfill and its environs.

° Severely contaminated groundwater plumes in both the shallow Vincentown and the deeper Red Bank aquifers appear to migrate

from the landfill in a northerly direction towards and into the Manasquan River.

° There is considerable leachate seepage, especially after rainfall, at the landfill. Contaminated surface water runoff from the landfill flows into the adjoining wetlands to the north and then into the Manasquan River.

° Low levels of volatile organic compounds and heavy metals have already been detected in the river water column and sediments, just downstream of the site.

° Previous response actions at this site include a response to a chemical fire at the landfill in 1978. A magnetometric study followed by the excavation and sampling of 69 drums was undertaken in 1981. In 1982, twenty monitoring wells were installed and sampled. In 1983, Manasquan River sediments were sampled and five additional monitoring wells were installed and sampled to further define the extent of the contamination. In 1984, a groundwater monitoring well located at the northeastern toe of the landfill was installed as part of the leachate treatability study, and air quality monitoring was performed.

° VERSAR, the responsible parties' (PRP's) contractor, has sampled the Manasquan River on four occasions from June 1983 to February 1984. Their data, which has been presented to the Region, shows low levels of volatile organics in the river.

° Notice and §3007 letters were sent throughout 1982. Additional Information Request Letters were issued in 1983 and early 1984. Notice Letters addressing the results of feasibility study and impending design were issued in late summer 1984.

° The objective of the proposed remedial action is to control the migration of contamination from the site to protect public health and welfare, with particular emphasis on maintaining safe drinking water supplies and the natural surrounding environment. Although there are no potable public or private wells currently believed to be threatened, an off-line potable water reservoir is planned at a location 16 miles downstream from Lone Pine. The contamination from the landfill may impact the recreational uses of the river and its environs, as well.

° In June 1983, Camp Dresser and McKee completed a draft Feasibility Study. Through a survey of available remedial action technology and an analysis of site conditions, six alternatives addressing source control were identified and evaluated:

1) No action with monitoring.

2) Surface cap (no containment).

3) Surface cap; containment by pumping (400 gpm) of contaminated groundwater; and treatment.

4) Containment by means of a surface cap and a slurry wall penetrating approximately 30 feet through Vincentown aquifer to the Hornerstown formation, an aquitard; internal pumping (30 gpm) to maintain a negative internal gradient; and treatment.

5) Containment by means of surface cap and a slurry wall penetrating approximately 140 feet through the Vincentown and Red Bank aquifers to the impermeable Navesink Marl; internal pumping (30 gpm); and treatment.

6) Drum excavation and removal; surface cap; interception (400 gpm) of contaminated groundwater; and treatment.

° Based upon the analyses conducted for the June 1983 draft Feasibility Study and the public comments received on this document, in May 1984, three additional remedial alternatives which address source control were identified and evaluated:

7) Containment by means of a surface cap and a 30-foot slurry wall; internal pumping (30 gpm) and flushing; and treatment.

8) Containment by means of a surface cap and a 30-foot slurry wall; limited excavation (3 acre area of known drum disposal) of source materials; internal pumping (30 gpm) and flushing; and treatment of internal pumpage not used for flushing.

9) Containment by means of a surface cap and a 30-foot slurry wall; limited excavation of source materials; internal pumping (30 gpm); and treatment.

Based upon an initial evaluation and screening of these alternatives, the following alternatives were developed for a more detailed analysis:

Remedial Alternative Present Worth Cost ($ million)

Alternative	Capital	O&M	Total Present Worth
3	13.2	12.9 (0.79)*	26.1
4	10.7	6.47 (0.32)	17.1
9	30.9	6.47 (0.32)	37.4

*(annual O&M)

The treatment costs in the above table assume on-site treatment of the extracted groundwater. Below is a comparison of on-site treatment of the extracted groundwater versus treatment at the Ocean County Utilities Authority (OCUA) wastewater treatment plant.

Comparison of Capital and Annual Costs for
On-Site and Off-Site Groundwater Treatment ($ million)

	Alternative		
	3	4	9
On-site Treatment System Capital Costs	2.19	0.92	0.92
On-site Treatment System Annual O&M Cost	0.67	0.23	0.23
OCUA Annual Charge	0.52	0.19	0.19
Option 1: 1 mile force main	0.26	0.21	0.21
Option 2: 4.5 mile force main	1.16	0.90	0.90

The recommended alternative (Alternative 4) includes on-site containment with a shallow groundwater cut-off wall and surface seal; internal pumping (30 gpm); and treatment. The total estimated present worth capital cost is $10.7 million. Annual operation and maintenance costs are estimated at $0.32 million (or $3.54 million present worth over 20 years). The present worth monitoring costs total $0.55 million for a total present worth cost of $17.1 million. A surficial drum cleanup at the adjacent borrow pit area and fence installation around the landfill will be performed during remedial implementation.

- o The specific treatment scheme for the extracted groundwater will be designated upon completion of the ongoing treatability studies.
- o An additional off-site groundwater investigation to determine the extent of the plume will also be performed.
- o The State has agreed with this approach.
- o The selected remedy is the cost-effective remedy for the site.
- o Monies are available the Fund to finance the remedy.

Lone Pine Landfill Site, New Jersey
Remedial Alternatives

Alternatives	Capital ($ mil)	Present Worth ($ mil)	Public Health Considerations	Environmental Considerations	Technical Considerations	Public Comment
1. No Action with monitoring.	0.04	0.62	Unacceptable. Potential for direct contact with leachate and on-site contamination. Potential threat to reservoir should more persistent compounds be released.	Continued production of leachate and contamination of ground and surface water. Continued threat to flora and fauna.		Strong public resistance
2. Surface Cap.	7.2	9.70	Removes direct exposure threat to leachate breakouts. Still potential threat to reservoir should more persistent compounds be released since site not contained.	Continued contamination of ground and surface water. Continued degradation of flora and fauna.	Common engineering practice.	Unacceptable to public. PRP's suggested remedial solution.
3. Cap, containment by groundwater pumping, and treatment.	13.2	26.1	Since source not contained by a physical barrier, failure of pumping system would present threat to reservoir.	Slower cleanup of ground and surface water than containment with physical barrier. Pumping failure would present threat to environment. Marginally less protection to flora and fauna than containment with cut-off wall.	No slurry wall constructed. Increased capacity extraction and treatment system Less reliable than containment with cut-off wall. Requires considerable pumping and O&M.	Community resistance to keeping contamination on-site.

Alternatives	Capital ($ mil)	Present Worth ($ mil)	Public Health Considerations	Environmental Considerations	Technical Considerations	Public Comment
4. Cap, shallow containment wall, and internal groundwater pumping and treatment.	10.7	17.1	Contamination within the landfill would be contained protecting reservoir and the recreational uses of the river. Physical containment provides greatest assurance of groundwater protection. Removes direct exposure risk.	Gradual restoration of flora and fauna in vicinity site. Gradual natural restoration of river and aquifer external to site. Prevents continued/increased contamination.	Reduced extraction well and treatment capacity. Easier to construct than deeper slurry wall, similar reliability.	Community resistance to keeping contamination on site.
5. Cap, deep containment wall, and internal groundwater pumping and treatment.	20.9	26.2	Contamination within the landfill would be contained, protecting reservoir. Marginally more protection than shallow wall.	Gradual restoration of flora and fauna in vicinity of site. Marginally more protection than shallow wall.	140 foot deep slurry wall just about extent of construction capability making it considerably more difficult to construct than the shallow wall.	Community resistance to keeping contamination on-site.
6. Drum excavation and removal, groundwater interception and treatment.	79.3	84.6	Reduces direct exposure risk. Reduced threat to reservoir. Increase risk to workers from fire/explosions and contact with hazardous substances.	Gradual restoration of flora and fauna in vicinity of site. Considerably more protection than cap and interception alternative. Potential for adverse air quality and odor impacts.	Significant safety and engineering problems. Waste quantity and nature of contamination unknown.	Community perceives excavation as most acceptable.

Alternatives	Capital ($ mil)	Present Worth ($ mil)	Public Health Considerations	Environmental Considerations	Technical Considerations	Public Comment
7. Cap, shallow containment wall, internal pumping, treatment, and flushing.			Potential for flushing of contaminants from system. Marginally more protection than containment.	Gradual restoration of flora and fauna in vicinity. Marginally more protection than containment.	Flushing not technically feasible for this site because of short-circulating and hydraulic infeasibilities. Containment still required.	Suggested by TRC.
8. Cap, shallow excavation internal pumping, flushing.			Increased risk to workers. Potential for removing part of source. Marginally more protection than containment.	Gradual restoration of flora and fauna in vicinity. Potential for adverse air quality and odor impacts. Marginally more protection than containment.	Flushing not technically feasible for this site because of short-circuiting and hydraulic infeasibilities. Containment still required.	Suggested by TRC.
9. Cap, shallow limited drum excavation, ground water treatment.	30.8	37.4	Reduces direct exposure risk. Reduced threat to reservoir by removing part of source. Increased risk to workers from fire/explosions and contact with hazardous substances.	Gradual restoration of flora and fauna in vicinity of site and aquifer external to site. Restoration capabilities equivilent to other shallow slurry wall contaminant options. Potential for adverse air quality and odor impacts.	Significant safety and engineering problems. Source strength unknown. Quantity of waste to be removed unknown.	Perceived as desirable by community.

Next Steps

Action	Date
- AA-OSWER approves ROD	September 21, 1984
- Amend State Superfund Contract for Design	September 28, 1984
- Award IAG for Design	September 28, 1984
- Start Design	November 1, 1984
- Complete Design	May 1, 1985
- Amend State Superfund Contract for Construction	June 1, 1985
- Award IAG for Construction	June 1, 1985
- Start Construction	July 1, 1986
- Complete Construction	July 1, 1987

Key to Figures, Tables, and Attachments

Figures

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Figure 2	-	Site Plan.
Figure 3	-	Stratigraphy Cross Section.
Figure 4	-	Soil Types and Slopes.
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Figure 8	-	Proposed Remedial Solution for Source Control.

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Table 2	-	Water Bearing Properties and Quality of Geological Formations in the Vicinity of the Site.
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Table 6	-	Summary of On-Site Soil Samples.
Table 7	-	Summary of Excavated Drum Samples.
Table 8	-	Patrial Listing of Wastes That May Have Been Disposed of in Lone Pine.
Table 9	-	Summary of Air Quality Sample Data.
Table 10	-	Remedial Alternative for the Lone Pine Landfill Site.
Table 11	-	Alternatives Undergoing Final Evaluation.
Table 12	-	Remedial Alternatives Costs Comparison.
Table 13	-	Comparison of Capital and Annual Costs for On-Site and Off-Site Groundwater Treatment.
Table 14	-	Selected Remedial Alternative Capital Costs.
Table 15	-	Annual Operation and Maintenance Costs for Selected Remedial Alternative.
Table 16	-	Remedial Alternative Implementation Schedule.

Attachments

Attachment 1	-	June 24, 1983 Public Meeting Anouncement Press Release.
Attachment 2	-	June 24, 1983 Public Meeting Attendees.
Attachment 3	-	August 1, 1984 Public Meeting Announcements Press Release.
Attachment 4	-	August 1, 1984 Public Meeting Attendees.
Attachment 5	-	Responsiveness Summary.
Attachment 6	-	State Review Process.

Summary of Remedial Alternative Selection
Lone Pine Landfill

Site Location and Description

Situated in a rural, marshy area, the 40-50 ft. high Lone Pine Landfill is located on Burke Road, off Elton-Adelphia Road, in Freehold Township, Monmouth County, New Jersey (see Figures 1 and 2). The 45-acre landfill, which is located about 500 feet south of the headwaters of the Manasquan River, about 1000 feet west of the 200-acre Turkey Swamp Fish and Wildlife Management Area, is situated on a 144-acre mostly wooded parcel owned by the Lone Pine Corporation. Along with municipal refuse and septage wastes, at least 17,000 drums and several million gallons of bulk liquid chemical wastes were disposed of in the landfill. The nature of these disposed materials is largely unknown.

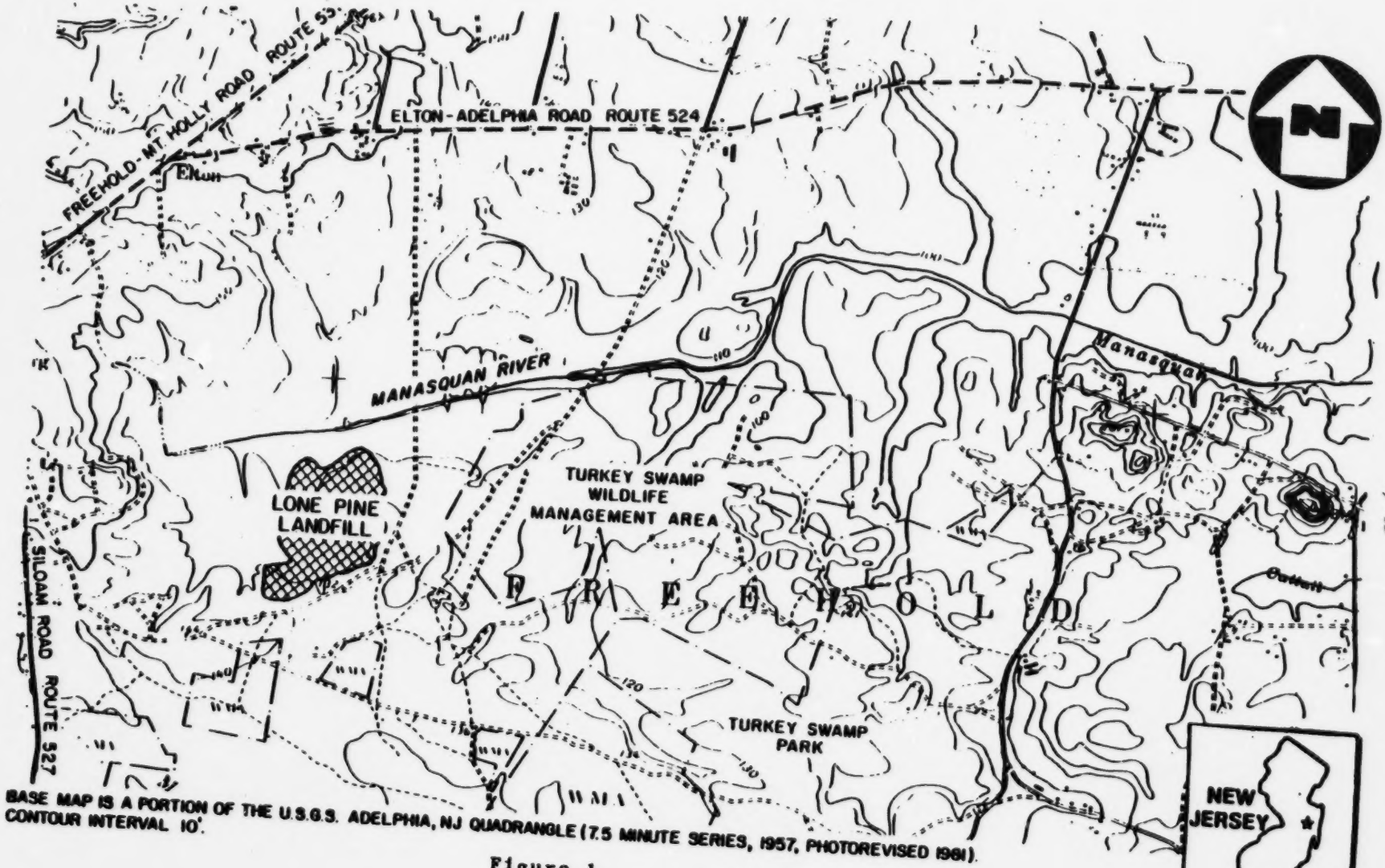
The landfill is bounded by Burke Road to the east and south, and a swamp to the west, which drains to the Manasquan River at the Landfill's northern boundary. The area in the vicinity of the Landfill is sparsely populated with only about half a dozen residences in the immediate vicinity, the closest being about 600 feet south of the landfill.

A local sportsman club, the Fin, Fur, and Feather Club, is located about 1000 feet to the east of the landfill. A 700-acre municipal potable water supply reservoir is planned for construction at a location 16 miles downstream of the landfill off the Manasquan River.

The landfill is located on relatively flat land which gradually slopes towards the Manasquan River to the north. The surrounding terrain is predominantly gently rolling Coastal Plains with small hills. The site lies within the 2.4 square mile subbasin of the regional Manasquan River watershed. Surface waters within the subbasin drain into tributaries of the easterly flowing Manasquan River. Groundwater in the immediate vicinity of the landfill provides a major source of water for the Manasquan River, which has a variable flow rate of approximately 2 to 70 cfs.

Figure 3 presents a generalized geological cross section in the vicinity of the site. Test pits around the landfill indicate that the water-bearing Vincentown sands is situated from several inches to several feet beneath the surface at the extreme east of the site, thickening in a wedge to a depth of about 30 feet towards the southeast. In the southwest portion of the site, a recent deposition of black organic topsoil is found on the surface.

Three major soil series have been identified in the immediate vicinity of the landfill: Atson, Lakehurst, and Lakewood series. The soils generally consist of gravelly sands, silty-gravelly



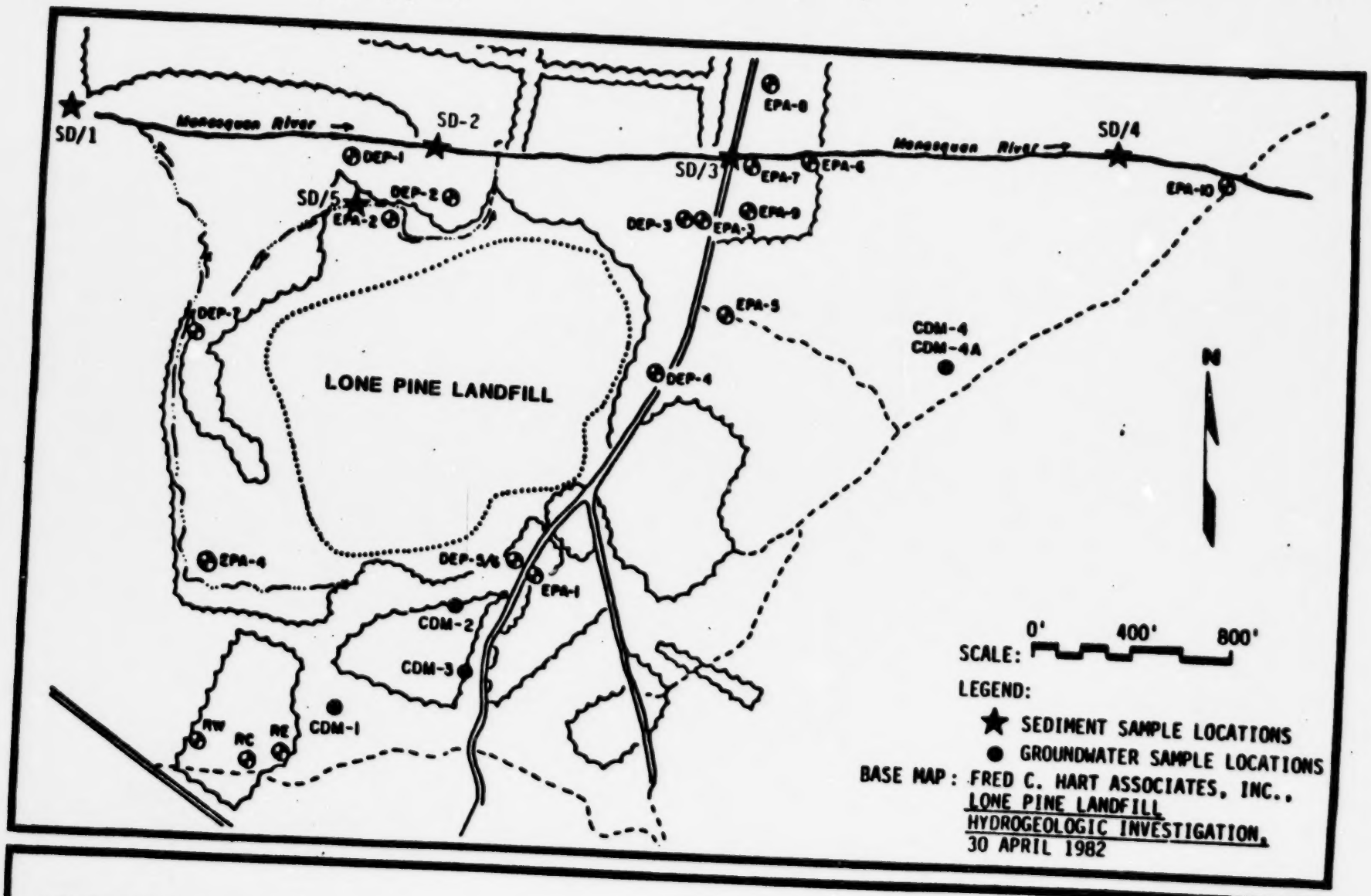
BASE MAP IS A PORTION OF THE U.S.G.S. ADELPHIA, NJ QUADRANGLE (7.5 MINUTE SERIES, 1957, PHOTOREVISED 1981). CONTOUR INTERVAL 10'.

Figure 1

LOCATION MAP
LONE PINE LANDFILL SITE, FREEHOLD, NJ

SCALE: 1" = 2000'

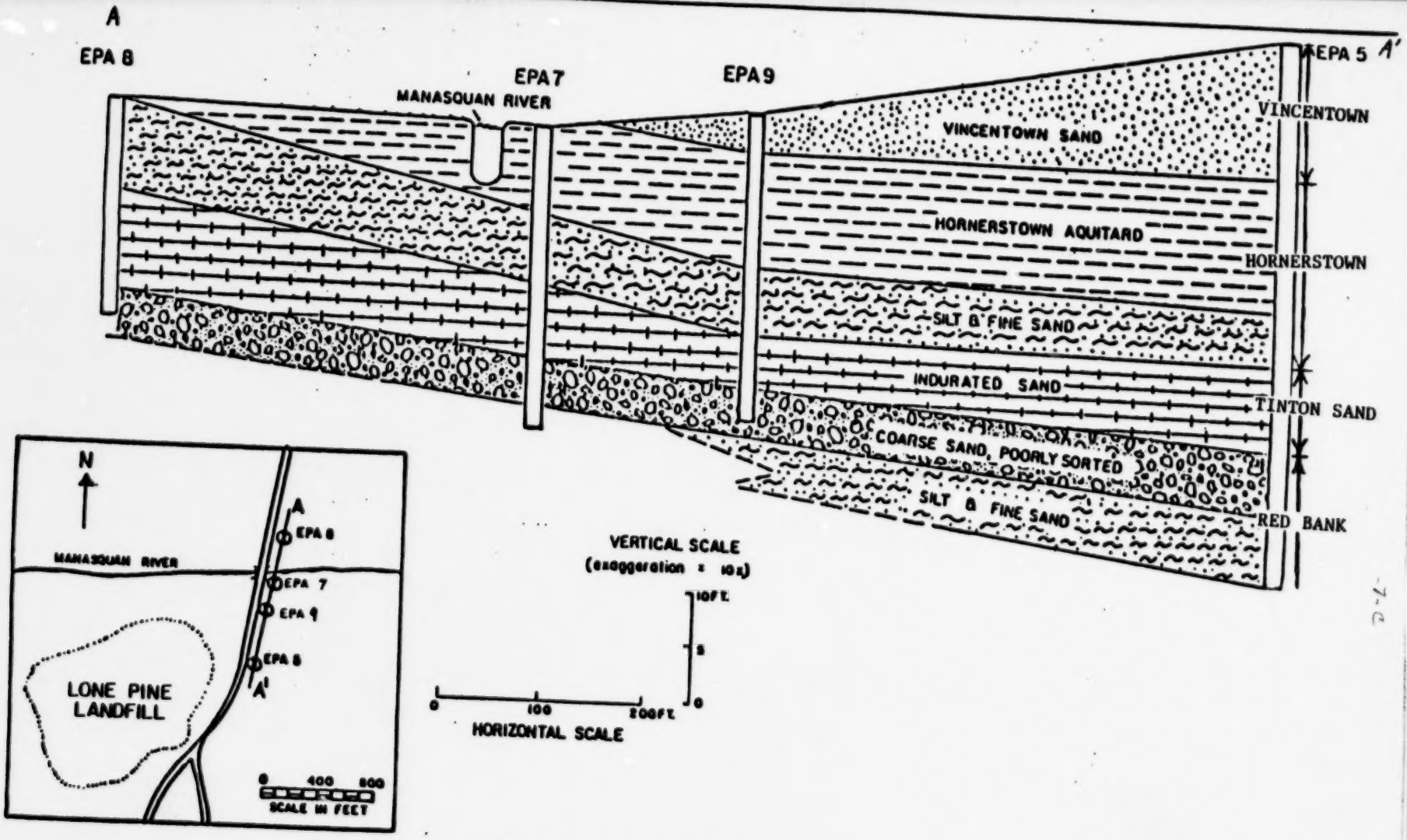
NUS CORPORATION
A Halliburton Company



LONE PINE LANDFILL

Figure 2

SITE MAP



SOURCE: FRED C. HART ASSOCIATES, INC., 1982

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LONE PINE LANDFILL

CROSS SECTION OF THE STRATIGRAPHY IN VICINITY OF LONE PINE LANDFILL

Figure 3

sands and clayey-gravelly sands, with high permeability rates, generally increasing with depth. Figure 4 shows the location of the various surficial soils found at the site and Table 1 indicates the properties of these soils. Lone Pine Landfill is situated in the Coastal Plain physiographic province. The site is underlain by unconsolidated gravel, sand and clay.

The Vincentown, which lies directly beneath the topsoil, is underlain by the Hornerstown formation. The Vincentown Sand consists of fine-to-medium-grained quartz sand to a sandy, clayey, limestone character in the upper level and greenish-gray micaceous, clayey glauconitic fine-to-medium-grained sand in the lower level. The underlying Hornerstown formation, consisting of 10-12 feet of a deep green, silty, glauconitic, fine sand with varying amounts of clay, functions as an aquitard (a semi-confining bed)in restricting the vertical movement of groundwater between the Vincentown and Red Bank formations. This is underlain by the Tinton Sand which ranges from 5 to 8 feet thick and is heavily indurated with siderite, a finely crystalline ferric carbonate. The Tinton Sand exhibites moderate permeability depending on the degree of cementation. This is underlain by the water-bearing Cretaceous Red Bank Sand. Test borings indicate the presence of several distinct stratigraphic units within the Red Bank Sand. The upper portion of the formation is partially indurated, glauconitic, silty, fine sand. This is underlain by a layer of coarse and poorly sorted sands followed by a layer of silt and fine sand.

Below the Red Bank formation lies the Navesink Marl formation at an estimated 140 feet below the surface. Deep water-bearing formation below the Navesink Marl include the Englishtown and Raritan-Magothy aquifers. Table 2 shows the water bearing properties of the geologic formations found in the vicinity of the site.

No floodplains have been designated within the limits of this portion of the Manasquan River.

Surface features include several on-site leachate ponds and a dozen or so visible drums and debris at the borrow pit adjacent to the landfill across Burke Road. A chainlink fence and gate restrict access along Burke Road.

Site History

The Lone Pine Landfill operated from 1959 until 1979 when it was ordered closed by a New Jersey Department of Environmental Protection (NJDEP) Administrative Order. Until it was closed, Lone Pine accepted over 17,000 drums containing chemical wastes along with municipal refuse, large volumes of septage, and millions of gallons of bulk liquid chemical wastes.

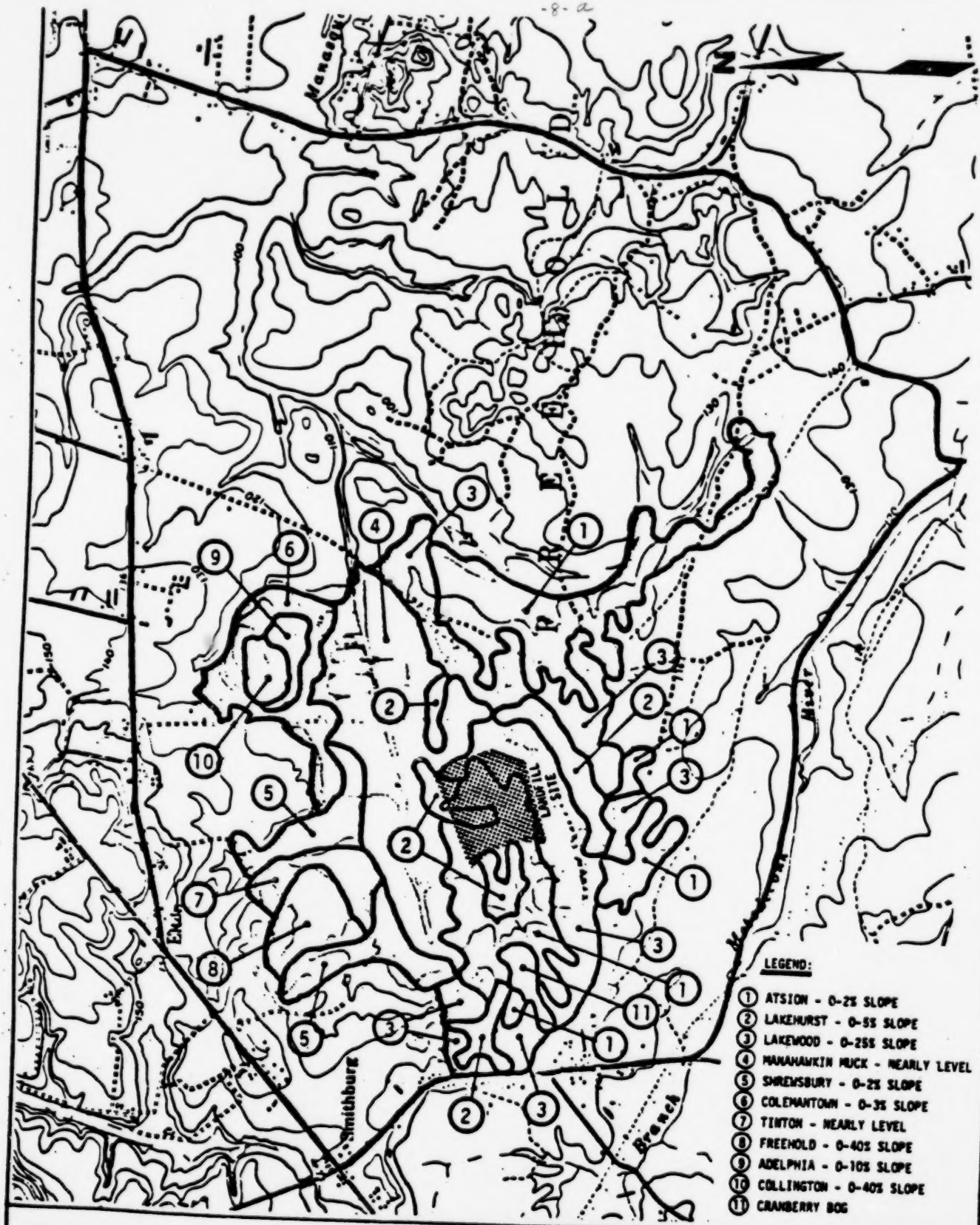

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Figure 4

LONE PINE LANDFILL

SOIL TYPES AND SLOPES

SCALE: 1"=2000'

Table 1

SOIL CHARACTERISTICS IN THE VICINITY OF LONE PINE LANDFILL

SOIL SERIES & SYMBOL	DEPTH TO SEASONAL HIGH WATER TABLE (Ft.)	TYPICAL VERTICAL PROFILE (Inches)	TEXTURE OF SUBSOIL	PERMEABILITY (in/hr)	NATURAL DRAINAGE CLASS	REACTION (pH)	ERODIBILITY	SUITABILITY FOR LANDFILL AND KIND OF LIMITATION
Matan (At)	1-1.0 (apparent Nov.-June)	0-60	Sand or Loamy sand subsoil	6.0-20	Poorly drained	3.6-5.0	Low-moderate	Severe seasonal high water table at depth of 0-12 inches.
Lakehurst (Lo)	1.5-3.5 (apparent Jan.-April)	0-60	Sand or Loamy sand subsoil	6.0-20	Moderately well drained	3.6-5.0	Low	Severe: seasonal high water table at depths of 1.5-3.5 hazard of ground-water pollution because of rapid permeability.
Lakewood (Lo)	6.0	0-60	Sand or Loamy sand subsoil	6.0-20	Excessively drained	3.6-5.0	Very low-low	Severe: Low amount of filter material; hazard of ground water pollution because of rapid permeability.
Shrewsbury (Sh)	0-1.0 (apparent Oct.-June)	0-60	Sandy clay loam subsoil, sandy surface layer lacking or > 20 inches	0.6-20	Poorly drained	3.6-5.0	Mod-low	Severe
Colemantown (Co)	0-1.0 (perched Oct.-June)	0-60	Clayey subsoil, high glauconite	0.2-0.6	Poorly drained	3.6-5.5	-	Severe
Tinton (To)	5.0+	0-60	Sandy clay loam, low glauconite	2.0-6.0	Well drained	3.6-5.0	Subject to wind erosion if left bare	Low amounts of filter material rapid permeability in substratum permits groundwater pollution.
Freehold (Fr)	70.0	0-60	Sandy clay loam, subsoil low glauconite	0.2-6.0	Well drained	3.6-5.0	Mod-High	Severe: slope
Adelphia (Ad)	15-4.0 (apparent Jan.-April,	0-60	Sandy clay loam subsoil, moderate glauconite	0.2-6.0	Moderately well drained	3.6-5.0	Mod-High	Severe: wetness
Collington (Co)	6.0	0-60	Sandy clay loam subsoil, moderate glauconite	0.6-6.0	Well drained	3.6-5.5	Mod-Low	Severe: slope
Hasbrouck to Rock (Ha) at surface		0-60	Organic material-muck sand, gravelly sand	>6.0	Very poorly	3.6-5.0	-	Severe: High water table, low bearing capacity; hazard of flooding.

Source: USDA Soil Conservation Service, 1982.

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Table 2

Water-Bearing Properties and Quality of
Geologic Formations In the Vicinity of Lone Pine Landfill

Geologic formation	Water-bearing properties	Water Quality
Vincentown Formation	Numerous domestic wells tap this sand; yields 10-50 gpm to domestic wells	Excellent Incidence of low pH and high iron content.
Hornerstown Sand	A poor aquifer; yields up to 5 gpm to domestic wells.	
Red Bank	Yields range from 3-30 gpm to domestic wells.	Acidic may require treatment for removal of iron.
Navesink Formation	Important to domestic consumers. Wells yield 10 gpm or less.	Excellent
Mount Laurel Sand Wenonah Formation	A single aquifer. Average yield 10 gpm. Maximum yield reported was 335 gpm.	Generally good, except for iron Moderately high hardness in some areas.
Marshalltown Formation	Not considered water-bearing in the county.	
Englishtown Formation	Average yield 25 gpm. Maximum yield reported 640 gpm. Average yield to large-capacity wells 410 gpm.	Excellent except for high iron content.
Woodbury Clay Merchantville Formation	Both formations act as a single aquiclude. Not water-bearing.	
Magothy Formation	Sands are discontinuous, and thickness variable. Maximum yield reported 250 gpm.	Generally good, except for iron and magnesium. Isolated problems have occurred with nitrates and some heavy metals, e.g., cadmium and chromium.
Raritan Formation	Contains most important aquifers. Yields range 100-1,400 gpm to large-diameter wells.	
Wissahickon Formation	No wells in this formation.	

Source: New Jersey Department of Conservation & Economic Development 1968

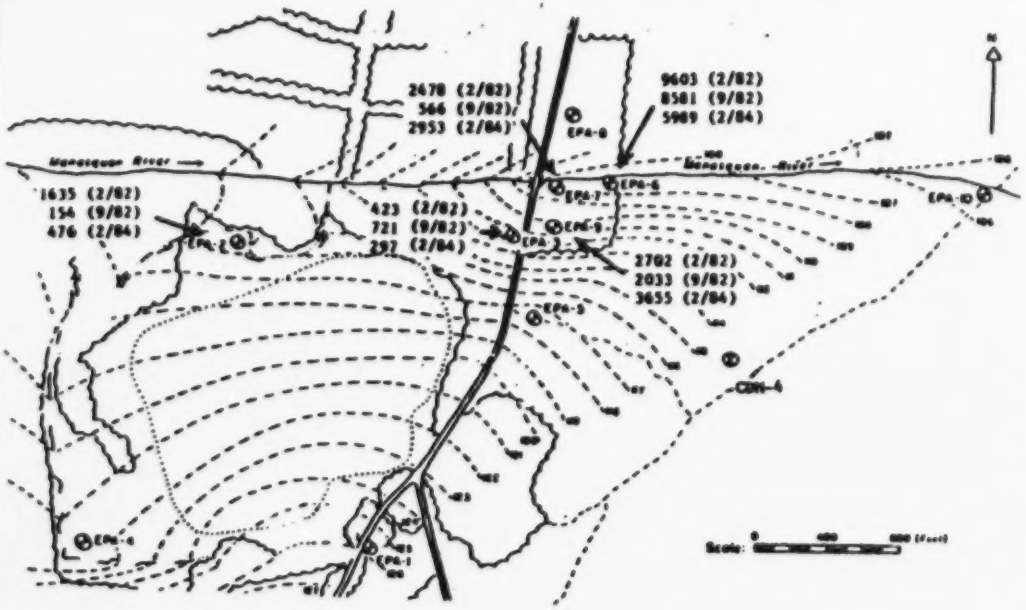
In the early 1970's, NJDEP unsuccessfully attempted to force the Lone Pine Corporation, the owner and operator, to update its operation to minimize the leachate and surface runoff problems at the landfill. Following a NJDEP sampling investigation in 1977 and a chemical fire and explosion in 1978, EPA sampled the leachate and the Manasquan River, detecting various organic compounds. By the end of 1979, NJDEP had closed the landfill to all wastes. An EPA inspection to determine the feasibility of a CWA §311-funded cleanup led to the recommendation that additional investigations be conducted on a high priority basis and that no §311 funds be activated. (Funding was not recommended because, at the time of the inspection, §311 actions were limited to incidents involving oil, and the State Attorney General had filed a suit against Lone Pine Corporation to insure proper closure.) Subsequent sampling studies indicated signficant levels of toxic organics and heavy metals in the groundwater and leachate, and low levels in the Manasquan River downstream of the site.

Following a magnetometric study in the summer of 1981, which indicated the possible presence of tens of thousands of steel drums, 69 drums were excavated. Thirty-five of these drums had retained partial contents with 25 containing sludge, and 10 containing liquid. A variety of organic priority pollutant substances, heavy metals, and pesticides were contained in these rusted, leaking drums.

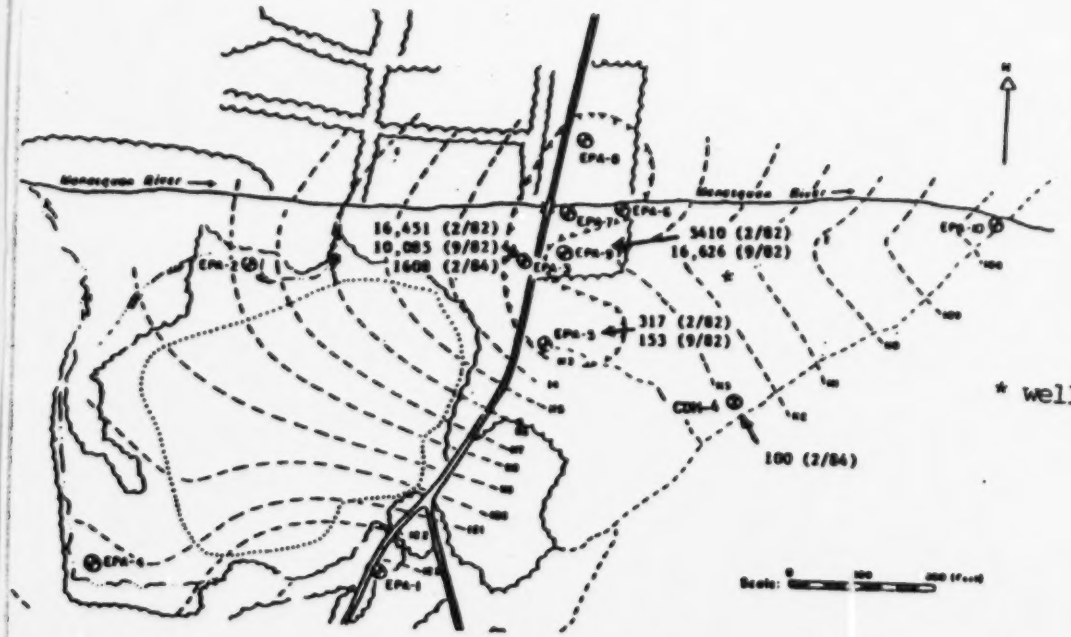
Based upon testimony stemming from the criminal trial of the principals of Scientific Chemical Processing (SCP), a waste processing firm, over 17,000 drums containing chemical wastes were illegally disposed of in the landfill. According to the testimony, large quantities of drummed solid and liquid wastes were sent to the landfill. The drum disposal operation at SCP involved the dumping of the materials in drums into large dumpsters. Where the drum could be totally emptied, it was sold to a drum reconditioner. When the drum could not be emptied, it was segregated and loaded into a dumpster for disposal at Lone Pine. If the drum was determined to contain solids at the bottom, it was considered not suitable for drum recovery and was disposed of, even though it might have contained considerable liquid content. Bulk disposal occurred also.

The results of a fall 1981 - winter 1982 hydrogeological investigation indicated severe groundwater contamination in both the shallow Vincentown and the deeper Red Bank aquifers, with the contamination appearing to migrate north and northeast, respectively, towards and into the Manasquan River (see Figure 5).

In July 1982, EPA and the State of New Jersey signed a State Superfund Contract to undertake a remedial investigation and feasibility study at the Lone Pine Landfill. As part of this study, in the Spring of 1983, additional field work including the



Vincentown Sands Aquifer
Water Table Surface
Measured on 3/31/82
Lone Pine Landfill



Red Bank Aquifer
Potentiometric Surface
Measured on March 31, '82
Lone Pine Landfill

* well not accessible for 2/84 sampling

CONTAMINATED GROUNDWATER MONITORING WELLS
Total Volatile Organics (ppb)
Figure 5

collection of Manasquan River sediment samples and an additional hydrogeological investigation was completed by Camp Dresser and McKee (CDM), the EPA Zone Contractor.

In July 1983, CDM completed a draft Feasibility Study. Following public review and comments, additional alternatives were evaluated and reported in a supplement to the Feasibility Study. This supplement was completed in May 1984 and submitted for public comment.

In May 1984, a groundwater monitoring well was installed at the northeastern toe of the landfill as part of the leachate treattability study.

In June 1984, CDM performed air quality monitoring at the site over a two day period.

In June, August, and November 1983, and February 1984, VERSAR, the contractor for the Generators Steering Committee, sampled the Manasquan River. The data from these investigations have been considered in the alternative analysis.

This fall, three monitoring wells will be installed through the landfill mound to better define the nature of the contamination emanating from the site and to assist in further describing the strata underlying the landfill.

The State of New Jersey has issued various orders requiring the Lone Pine Corporation to take any steps necessary to prevent leachate and runoff contamination. In addition, the State Attorney General has filed suit against the Corporation to insure proper closure of the landfill. On the federal level, the landfill's former general manager pleaded guilty to charges related to illegal dumping of hazardous waste at the site. A jury convicted three principals of Scientific Chemical Processing, a waste processing firm that used Lone Pine illegally to dispose of drummed and bulk wastes.

Current Site Status

There are four potential routes of exposure associated with the Lone Pine Landfill: direct contact, surface water, groundwater, and air.

The landfill is located adjacent to the Turkey Swamp Fish and Wildlife Management Area which is used extensively for hunting and fishing. The site is accessible to game, which through the process of nesting or feeding on the site, may introduce contaminants into the human food chain.

There are three intermittent feeder streams that lead into the 6-8 foot wide Manasquan River at its headwaters: two

streams which originate in the woodlands to the north and northeast, and a stream to the south which winds through the northeast section of the site. Leachate has been observed flowing from the toe of the landfill through the woods into the marsh adjoining the Manasquan River and directly into the river itself via the stream that winds through the northeast section of the site. This leachate problem appears to be most pronounced following storm events. Samples of this leachate have indicated high levels of volatile organic compounds.

A sediment sampling investigation was performed in the Manasquan River and the southern tributary adjacent to the landfill. The investigation indicated the presence of low levels of contamination in the tributary's sediments. This contamination is attributed to the leachate and surface runoff.

The results of a hydrogeological investigation indicated severe groundwater contamination in both the shallow Vincentown and the deeper Red Bank aquifers beneath the landfill.

Water surface elevations in the wells installed during the hydrogeological investigation indicate that groundwater in the surficial Vincentown aquifer generally moves north, turning eastward to parallel the direction of the flow in the Manasquan River.

Since high concentrations of contaminants were found in the deeper Red Bank aquifer beneath the landfill, it is apparent that there is a downward vertical movement of pollutants from the Vincentown to the Red Bank formation. This further indicates that the Hornerstown formation does not function as a confining layer. Once the contaminants enter the semi-confined Red Bank aquifer, they appear to migrate northeasterly towards the Manasquan River. Since upward vertical gradients between the landfill and the river were found, it is believed that contaminants in the Red Bank aquifer migrate back upwards into the Vincentown aquifer, eventually discharging into the Manasquan River.

When the landfill was constructed and operated, portions of the Vincentown Sands aquifer were excavated down to depths of as much as 10 feet below grade. Therefore, even though the drums were disposed of in the latter years of the landfill's operation, because they were disposed of by dumping off the edge of a truck onto the working face of the landfill drums may be located deep enough in the landfill to come into contact with the water table. It is also likely that residual pools of non-aqueous fluids from ruptured drums and from bulk liquid dumping may have settled in the lower depths of the landfill, providing a continuing source of contamination to the Vincentown aquifer as the wastes resolublize.

The general area in the vicinity of the landfill is sparsely populated: The nearest private wells (see Figure 6) include three upgradient residential wells screened in the Vincentown aquifer, the closest of which is approximately 600 feet south of the landfill; a nonresidential well screened in the Englishtown aquifer located approximately 1000 feet east of the landfill; and several residential wells screened in the Vincentown aquifer, located about 1/2 mile north of the site across the Manasquan River. (As indicated previously, groundwater data indicate that contamination apparently does not migrate north of the river.)

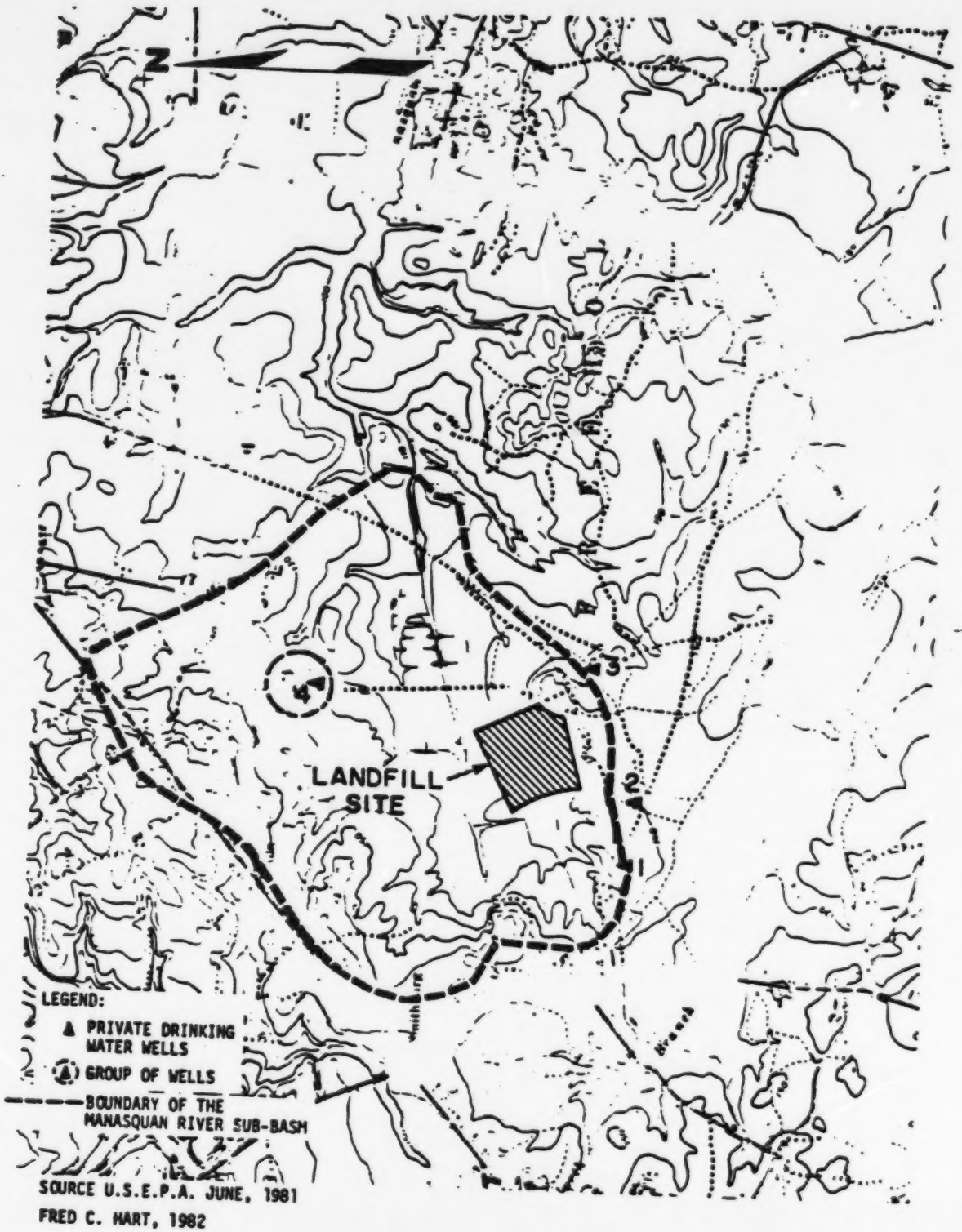
Approximately 85% of the Township residents are served by a municipal well system consisting of six wells, the closest of which is located approximately 4 miles northeast of the site (see Figure 7). Based upon the available data, it is believed that no existing groundwater drinking water supplies are presently threatened with contamination since the river apparently serves as a hydrogeological barrier and sink for the contaminated groundwater. (The monitoring well north of the river has consistently been found to be clean.) However, as a result of the surface runoff and leachate, and the input of the contaminated Vincentown and Red Bank aquifers into the river, low levels of organic compounds and heavy metals have been detected in the Manasquan River adjacent to and just downstream of the site. Surface water in the vicinity of the site is a major environmental concern since it provides water to wildlife and supports a variety of aquatic biota further downstream. In addition, the river is used for recreation and limited irrigation and a reservoir is planned for a site 16 miles downstream of the landfill.

The major class of contaminants currently being released from the landfill are volatile organic compounds, most notably benzene, chlorobenzene, methyl chloride, toluene, and vinyl chloride. A second class of compounds, base neutral extractables, in particular, isophorone and phthalates, are being released as well.

Tables 3, 4, 5 and 6 indicate the quantities of the contaminants found in the surface and groundwater, sediments, and on-site sludge, respectively. Many of these compounds are toxic and potential carcinogens.

Table 3
Summary of Manasquan River
Surface Water Analytical Data

Compound	Maximum Concentration (ppb)	
Volatile Organics	EPA	VERSAR*
Benzene	25	19
Chlorobenzene	140	
1,2-Dichloroethane	120	

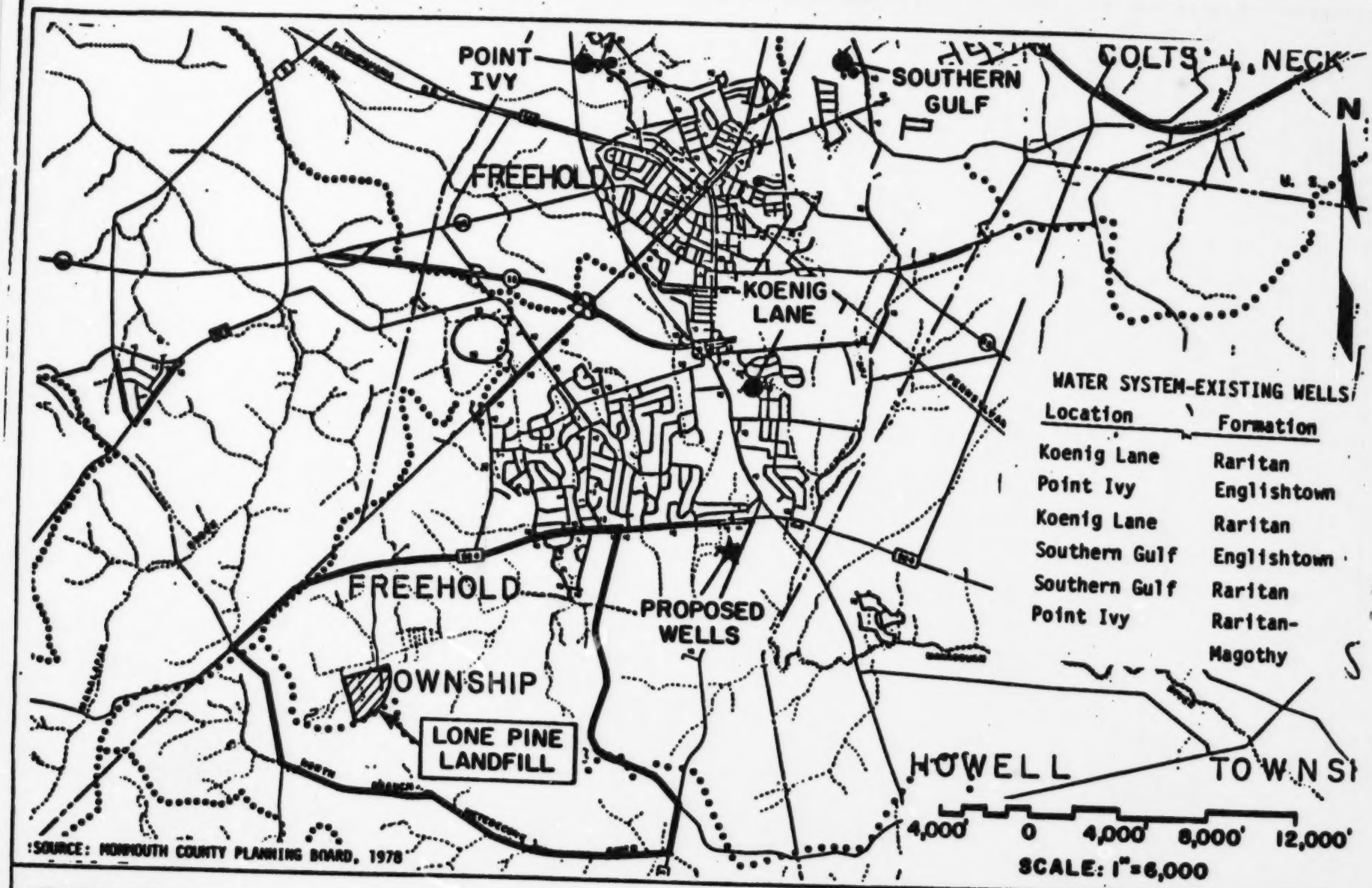


CDM

Figure 6

LONE PINE LANDFILL

LOCATION OF PRIVATE DRINKING WATER WELLS



CDM

environmental engineers, scientists, planners & management consultants

Figure 7

LONE PINE LANDFILL

LOCATION OF EXISTING & PROPOSED DRINKING WATER WELLS

Volatile Organics (Cont.)	EPA	VERSAR*
1,1-Dichloroethane	220	
1,1-Dichloroethene	23	
1,2-trans-Dichloroethene	29	
Ethylbenzene	280	9
Methylene chloride	35	
Tetrachloroethene	32	
Toluene	26	12
Trichloroethene	28	
Trichlorofluoromethane	15	
Vinyl chloride	440	

*Contractor for Generators Steering Committee

Table 3
Summary of Manasquan River
Surface Water Analytical Data (Cont')

Compound	Maximum Concentration (ppb)	
	EPA	VERSAR*
Acid Compounds		
Benzoic acid	280	
2-methylphenol	44	
4-methylphenol	400	
Phenol	trace	1.6
Base/Neutral Extractables		
4-methyl-2-pentanone	4200	
Bis (2-ethylhexyl)phthalate	trace	
Chloromethane	13	
Di-n-butyl phthalate	trace	
Diethylphthalate	24	
Naphthalene	170	
O-xylene	340	
Phenanthrene	trace	
Inorganics (ppm)		
Aluminun	1.3	0.35
Arsenic	0.013	trace
Barium	1.0	0.05
Cadmium	0.012	trace
Iron	380.	20.3
Lead	0.049	trace
Manganese	1.2	0.1

Inorganics (ppm)		
Tin	0.052	trace
Zinc	0.13	0.02

*Contractor for Generators Steering Committee

Table 4

Summary of Groundwater Analytical Data--EPA Wells

Compound	Maximum Detected Concentration (ppb)
Base/Neutral Extractables	
Bis(2-ethylhexyl) phthalate	523
Di-n-Octyl phthalate	57
Acid Compounds	
Pentachlorophenol	70
Phenol	625
Volatile Organics	
Benzene	1939
Chlorobenzene	97
Chloroform	8
1,2-Dichloroethane	1655
1,1-Dichloroethane	208
1,1-Dichloroethene	98
1,2-trans-Dichloroethylene	2128
Ethylbenzene	3325
Methylene Chloride	527
Tetrachloroethylene	76
Toluene	4708
Trichloroethene	370
Trichloroethylene	1423
Vinyl Chloride	334
Inorganics (ppm)	
Aluminum	80
Arsenic	0.042
Barium	0.82
Cadmium	0.77
Chromium	1.9
Copper	1.3
Iron	14,000
Lead	4.8
Manganese	0.91
Zinc	39.

Table 5

Summary of Manasquan River Sediment Analytical Data

Compound	Maximum Detected Concentration (ug/kg)
Base/Neutral Compounds	
Bis (2-ethylhexyl) phthalate	<400
Volatiles	
Benzene	31
Chlorobenzene	<2.5
Ethylbenzene	140
Methylene Chloride	478
Fluorotrichloromethane	7
Styrene	<2.5
O-xylene	7.4

Table 6
Summary of On-Site Soil Samples

Compound	Detected Concentration (ppb)
Volatiles	
Benzene	2900
Chlorobenzene	4100
1,2-Chloroethane	260
Chloroform	95
1,1-Dichloroethylene	6
Ethylbenzene	25,000
Methylene Chloride	170
1,1,2,2-Tetrachloroethane	1040
Tetrachloroethylene	12,000
1,1,1-Trichloroethane	1600
1,1,2-Trichloroethane	34
Trichloroethylene	24,000
Toluene	80,000

Based upon the results of a magnetometric investigation in 1981, 69 drums were excavated from 4 of 8 locations coinciding with magnetometric profiles showing large anomalies. The drums, containing solids, liquids, and viscous sludges, ranged from empty to 3/4 full. The solid samples obtained, varied from a thick, black polymer-like substance to a black and brown sludge. The liquid samples were a variety of colors. The results from the

sampling of 35 of the drums that contained waste materials are delineated in Table 7. An evaluation of this data indicates the presence of various organics, pesticides, and heavy metals solids and sludges.

Table 7

Summary of Excavated Drum Liquid, Viscous Material, Sludge and Solid Samples

Compound	Maximum Detected Concentration (ppm)			
Base/Neutral Extractables	**Liquid**	**Viscous material**	**Sludge**	**Solids**
Nitrobenzene	-	-	-	1800
Bis(2-ethylhexyl)phthalate	16.	-	2200	19,000
Butyl benzyl phthalate	3.5	-	-	4500
Di-n-butyl phthalate	54.	1200	1000	13,000
Naphthalene	1.1	2200	400	-
Di-n-octyl phthalate	1.9	-	340	-
1,4-Dichlorobenzene	0.11	-	-	-
Diethyl phthalate	32.	3700	3600	4500
Benzo (a)pyrene	3.7	-	-	-
Isophorone	-	-	3200	-
Pesticides				
Aldrin	-	-	0.4	57
4,4'-DDT	-	-	-	1.43
Alpha-endosolfan	-	0.2	1.68	22.
Heptachlor	-	-	0.82	33.
Heptachlor epoxide	-	-	120.	-
Alpha-BHC	-	-	-	-
Beta-BHC	-	-	0.82	105.
Delta-BHC	-	-	0.17	-
PCB-1260	-	0.71	-	-
Acid Compounds				
2-nitrophenol	3.6	-	-	-
phenol	50.	-	-	-
Volatile organics				
Benzene	27.	110.	150.	8.5
Chlorobenzene	-	-	0.81	4.8
1,2-Dichloroethane	11.	-	38.	10.
1,1,1-Trichloroethane	-	-	0.79	0.7
1,1,2-Trichloroethane	-	-	-	14.
Chloroform	0.21	-	0.63	3.2

Volatile organics	Liquid	Viscous material	Sludge	Solids
1,1-Dichloroethylene	0.16	-	0.16	0.18
1,2-trans-Dichlorethylene	1.4	-	7.1	8.3
Ethylbenzene	43.	2000.	300.	3400.
Methylene Chloride	340.	160.	240.	38.
Tetrachloroethylene	410.	28.	52.	58.
Toluene	2400.	220.	5600.	5900.
Trichloroethylene	4.5	-	8.6	19.
Inorganics				
Arsenic	80	200	230	80
Antimony	230	68	780	320
Chromium	1400	24	1000	1600
Beryllium	3	2	9	3
Cadmium	14	trace	trace	140
Copper	2400	210	29,000	610
Lead	410	20	8900	500
Nickel	2000	39	200	300
Selenium	40	100	trace	1900
Silver	18	52	12	50
Thallium	40	100	trace	trace
Zinc	5800	97	1200	880

Table 7

Summary of Excavated Drum Liquid, Viscous Material, Sludge and Solid Samples

DESCRIPTION OF SAMPLES	
Sample description	Remarks
Solid clear glassy material (possibly a polymer)	Sampled from a 3/4 full drum. Sample had to be chipped by chisel. OVA and PID readings showed no response.
Transluscent thick polymer-like material	Sampled from a 3/4 full drum. Sample had to be chipped by chisel. OVA and PID readings showed no response.
Solid polymer-like material	Sampled from a 3/4 full drum. Sample had to be chipped by chisel. OVA and PID readings showed no response. Adequate sample could not be collected and was not submitted for analysis.
Dark brown, viscous material	Sampled from a 3/4 full drum. OVA and PID readings showed no response.
Solid, polymer-like material	Sampled from a 3/4 full drum. OVA and PID readings showed no response. Adequate sample could not be obtained and was not submitted for analysis.
Oily solid material	Sampled from a semi-crushed drum. PID picked up aromatic compounds.
Standing water	Groundwater sample.
Standing water	Groundwater sample.
White crystaline solid	Sampled from an open drum.
Gluey grey sludge-like material	Sampled spilled material from a crushed drum. OVA reading was 200 ppm.
Grey sludge-like material	Sampled from an open crushed drum.

Table 7 continued

DESCRIPTION OF SAMPLES

Sample description	Remarks
Blue liquid	Sampled from a leaking semi-crushed drum.
Black sludge	Sampled from a semi-crushed drum.
Black solid/sludge	Sampled from a semi-crushed drum.
White sludge	Sample from a semi-crushed drum.
Black water	Two (2) groundwater samples.
Red solid	Sampled from a semi-crushed drum.
Black liquid	Sampled from a leaking drum.
White liquid	Sample from a leaking drum.
Black solid	Sampled from a semi-crushed drum.
Grey tan solid	Sampled from a semi-crushed drum.
Pink liquid	Sampled from a 3/4 full drum. OVA reading was greater than 1000 ppm. Drum had bluish color similar to Ashland Chemical drum.
Yellow liquid	Sampled from a leaking drum.
Black liquid	Groundwater sample.
Black solid/sludge	Sampled from spilled materials of a crushed drum.
Brown solid	Sampled from a semi-crushed open drum.

Table 7 continued

DESCRIPTION OF SAMPLES

Sample description	Remarks
Brown viscous sludge	Sampled from 3/4 full drum. OVA reading was 350 ppm.
Black liquid	Sampled from a drum. OVA reading was greater than 1000 ppm.
Viscous sludge	Sampled from a 3/4 full drum. OVA reading was greater than 1000 ppm. Drum had Ashland Chemical markings. Other distinct marking was 1044-7-10.
Black liquid	Sampled from a 3/4 full drum. OVA reading was greater than 1000 ppm.
Grey powdery solid	Sampled from a 1/2 full drum. OVA reading was greater than 1000 ppm.
Purple crystalline solid	Sampled from a 1/2 full drum.
Red powdery solid	Sampled from a 3/4 full drum.
Viscous liquid	Sampled from a 3/4 full drum. OVA reading was greater than 1000 ppm. Drum had Ashland Chemical markings.
Black liquid	Sampled from a semi-crushed drum.
Black sludge	Sampled from material spilled from semi-crushed drums, faint red color coating, marking could not be read.
Black sludge	Sample apparently shaped by being in a drum.
Red solid material	Sampled from an open crushed drum. OVA reading was greater than 1000 ppm.
Black standing water	Groundwater sample.

Although there is evidence of severe groundwater contamination in the vicinity of the site and distressed vegetation on and adjacent to the landfill, only low levels of contamination have to date been detected in the adjacent Manasquan River. This may be due to volatilization taking place in the river. Additional groundwater investigation will better define the extent of off-site contamination. Several hundred yards downstream of the site, these compounds have not been detected. However, since this landfill is "young" in terms of how recently many of the hazardous substances were disposed of (late 1970's), it is believed that the currently detected compounds may not be totally representative of the wastes that were disposed of and, consequently, of the wastes that may eventually be discharged to the environment. One reason for this is that the various contaminant adsorptive, absorptive, and density properties may affect the introduction of these contaminants into the groundwater. Other possible reasons include the presence of intact drums containing unreleased wastes, the perching of contaminants in impermeable zones within the landfill, or the presence of solid residues that will solublize when exposed to water. As a result, a major concern is the potential threat to the thousands of residents of Monmouth and northern Ocean Counties who will receive their drinking water from the planned downstream reservoir, should a release of more persistent pollutants from this uncontrolled landfill occur sometime in the future. Public recreational areas downstream of the site, as well as local and downstream flora and fauna, may also be impacted from such a release.

The concern over the latent threat of release of highly toxic compounds from the landfill is based upon the data derived from the drum excavation and sampling program, as well as the results of a careful review of testimony presented at the Scientific SCP trial and responses stemming from information requests of companies. From these sources, a partial listing of wastes that were transported to SCP has been compiled. Because of the illegal nature of the operation, records as to which of these wastes were ultimately disposed of at Lone Pine are not available. However, based upon a review of the trial transcripts, it is clear that Lone Pine was used by SCP for the disposal of large quantities of drummed waste and also large volumes of bulk waste. The drums contained liquids, solids, and sludges. The sludges were likely to have been highly contaminated due to contact with drummed material emptied into dumpsters during the separation activities at SCP. The sludges also had a high moisture content, at times being as much liquid as solid. Significant amounts of hazardous substances were also transported to the site by transporters including Freehold Cartage.

The compiled partial listing of SCP wastes presents a best guess approximation of what might have been disposed of in the landfill. Many of the hazardous substances included on this list are contaminants currently detected in high concentrations

in the groundwater, including benzene, chlorobenzene, methylene chloride, and toluene. Significant quantities of organics and heavy metals that have not been detected in the groundwater, have also been identified as having been accepted by SCP, and may have been disposed of in the landfill. Table 8 shows a partial listing of drummed wastes that may have been illegally disposed of at Lone Pine by SCP.

It has been suggested that the level of contamination present in the groundwater has been decreasing over time. However, by evaluating the data, it can be seen that this does not appear to be true. Referring to Figure 5, while the total volatile organic concentrations in the Vincentown appear to be relatively constant, except for one monitoring well that has decreased by an order of magnitude, there is an order of magnitude increase in one Red Bank monitoring well and contamination has been detected in a previously clean well. In addition, samples from the monitoring well installed at the toe of the mound for the leachate treatability study, has shown total volatile organic concentrations significantly higher than the concentrations detected in the monitoring wells downgradient of the site (see Table 4): 160,000 ppb Methylene Chloride at the toe of the mound, as compared to 527 ppb in the plume; 15,000 ppb Trichlorethylene versus 1423 ppb; 3700 ppb Benzene versus 1939 ppb; 4200 ppb Ethyl Benzene versus 3325 ppb; and 24,000 ppb Toluene versus 4708 ppb. The data apparently indicates that considerable quantities of contamination are currently being released from the landfill.

Despite gross contamination of the aquifers beneath and downgradient of the landfill, the present impact on human health is believed to be low since, currently, there are no known downgradient receptors. Presently, hunters, dirt bikers, and other trespassers who might come into direct contact with the leachate seeping from the landfill are the only known human receptors believed to be threatened.

Wildlife that feed and nest on the landfill and its vicinity may also be exposed to and accumulate contaminant concentrations from the landfill. These fauna, if hunted, may also introduce contamination into the human food chain.

In March 1984, a sample taken from downgradient monitoring well CDM-4A (see Figure 2) in the Red Bank formation, identified contamination in a location that tested clean for organics previously. Also a sample from previously contaminated downgradient well EPA-5, recently tested clean for organics. Since a link has been established between the wastes in the landfill and the contamination found in surface and groundwater in the vicinity of the site, on-site remedial measures were evaluated. The recent groundwater sampling, however, has raised questions regarding the extent of the contaminated plume and the actual contaminant transport route. As a result, the monitoring wells will be

resampled and several additional wells will be installed as part of the proposed additional off-site hydrogeological investigation. Based upon this evaluation, the extent of the contaminant plume and the need for off-site plume control will be determined.

In June 1984, air quality samples were taken at the site during a two day period. Table 9 shows the results of this investigation.

Table 8

Partial Listing of Wastes That May Have Been Disposed of At Lone Pine

Acetophenane
Acids
Acrylates
Acrylonitrile
Aldehydes
Amides
Anthracite
Antimony
Aromotics
Arsenic Trioxide
Benzene
Butanediol
Butanol
Butyl Phenol
Carbon Tetrachloride
Caustics
Chlorobenzene
Chloroethane
Chloroform
Chromic Acid
Copper Waste
Cresyl Acid

Cyclohexane
Dichlorobenzene
Dimethyl Ketone
Diphenyl
Diphenyl Methane
Diphenyl Oxide
Dyes
Epoxy Wash
Ethanol
Ethers
Ethyl Acetate
Ethylene Dichloride
Flamable Wastes
Fluroide
Formaldehyde
Halogenated Mix, Spent
Heptaldehyde
Heptane
Heptene
Hydazine
Inks
Kerosene
Lacquer, spent
Latex Residue
Maleic Anhydride
Melamine
Mercury Salts
Methanol
Methyl Bezamid
Methyl Cellulose acetate
Methyl Chloroform
Methyl Isobutyl Ketone
Methyl Vinyl Ketone
Mithramycin
Monomers
Nail Polish Wastes
Naphthalenes, chlorinated
Nickel, Waste Plating Solution
Nitrates
Nitroaniline
2-Nitropropane
Otoledine
Paint Thinners and Sludges
Paladium Catalyst
Pharmaceutical wastes
Phenols
Phosphoric Acid
Pigment, Waste
Plasticizers
Polymers
Pyridine
Radioactive Residues
Resins
Sodium Cyanide
Solvent, Spent
Toluene
Trichloroethane
1,2,3 Trichloropropane
Varnishes
Varsol, waste
Vinyl Pyridine
Xylene
Zinc

Table 9

Summary of Air Quality Analytical Data

Compound	Maximum Detected Concentration (mg/m^3)
1,1,1-Trichloroethane	0.17
Trichloroethylene	0.08
Benzene	0.08
1,1,2,2-Tetrachloroethylene	0.04
Toluene	0.69
Ethylbenzene	0.14

Based upon this data, while volatile organics are detected, it does not appear that there is a significant air contamination problem at this time.

Enforcement

Potentially responsible parties (PRPs) have been identified.

The Lone Pine Steering Committee is a generator committee which was organized to negotiate with EPA. Currently, at least eight PRP's are participating and four meetings have been held. The Committee has provided a considerable number of comments on the draft study and has provided data representing their own field investigations. The Committee has offered to cap the landfill and provide additional source control measures in the future should the cap prove to be an effective source control measure, however, no supporting documentation has been provided by them to support their recommended alternative and, as of this date, no settlement has been reached.

It is EPA's intention to negotiate with the PRP's for the implementation of the remedy. If these negotiations are fruitless, or if it appears that the PRPs are not negotiating in good faith, then EPA may consider the issuance of a CERCLA §106 Administrative Order for the construction of the remedial action.

Alternatives Evaluation

The primary objective of the feasibility study was to evaluate remedial alternatives using a cost-effective approach consistent with the goals and objectives of CERCLA. A cost-effective remedial alternative as defined in the NCP (40 CFR 300.68J) is "the lowest cost alternative that is technologically feasible and reliable

and which effectively mitigates and minimizes damage to and provides adequate protection of the public health, welfare, or the environment." The NCP outlines procedures and criteria to be used in selecting the most cost-effective alternative.

The first step is to evaluate public health and environmental effects and welfare concerns associated with the problem. Criteria to be considered are outlined in Section 300.68(e) of the NCP and include such factors as actual or potential direct contact with hazardous material, degree of contamination of drinking water, and extent of isolation and/or migration of the contaminant.

The next step is to develop a limited list of possible remedial alternatives which could be implemented. The no-action alternative may be included on the list.

The third step in the process is to provide an initial screening of the remaining alternatives. The costs, relative effectiveness in minimizing threats, and engineering feasibility are reviewed here. The no-action alternative may be included for further evaluation when response actions may cause greater environmental or health damage than no-action responses. A no-action alternative may also be included if it is appropriate relative to the extent of the existing threat or if response actions provide no greater protection.

With respect to the no-action alternative, the results of the field investigation and the feasibility study indicate that there are significantly high levels of contamination at Lone Pine. Specifically, the groundwater beneath the site is severely contaminated and is migrating towards and into the Manasquan River. The NJDEP has established a maximum concentration of total volatile organic compounds for possible closure of drinking water wells as 100 ppb. Although there are no drinking water wells immediately affected by the site, as was shown in Table 4, groundwater samples have been far in excess of this value. Also, the concentrations of some of the detected contaminants are far in excess of exposure levels based upon unit cancer risk (UCR) values which have been identified by EPA for drinking water. These levels are based upon an incremental increase in cancer risk of 10^{-6} assuming exposure to a 70 Kg adult consuming 2 liters of water per day. The groundwater concentrations of Benzene, 1,2-Dichloroethane, and 1,1-Dichloroethene are 2881, 1749, and 2908 times their UCR levels, respectively. In addition, considerable quantities of leachate are oozing from the landfill into the river. Low levels of volatile organics have been detected in the river just downstream of the site. Although significant contaminant levels are believed to be entering the river (samples from the monitoring wells located on the southern bank of the river are severely contaminated), the lower concentrations detected in the river may be attributable to volatilization. Additional hydrogeologic

investigations are planned to better define the extent of off-site groundwater contamination and to answer questions raised concerning whether the plume of contamination fully discharges into the Manasquan River.

In addition, the landfill's unprotected side slopes are subject to erosion, increasing the potential for the transport of contaminants into the Manasquan River. Also, the erosion may expose wastes in the future, thereby creating additional health risks due to direct contact.

In addition, any future spread of contamination if no action is implemented could adversely impact future growth and development in areas north of the landfill that are currently zoned for residential development. Parklands adjacent to the site could also be adversely affected if the portion of the Manasquan River located within the park is unable to support waterfowl and other forms of wildlife.

Two major concerns have been identified in relation to this site. The first is primarily a public health concern related to the 35 million gallon per day reservoir which is planned at a location 16 miles downstream from the site. (The dilution factor associated with the 16 mile distance from the site to the proposed reservoir intake is estimated to be 55:1 based upon the ratio of drainage areas. It can be expected that any volatile organics would have volatilized by the time they reached the reservoir, however, relatively little dilution is provided for persistent compounds.) Because of the uncertainty of the nature of the wastes disposed of in the landfill, there is concern about future releases of more persistent compounds from this uncontrolled site. A change in the nature of the contamination currently emanating from the landfill may impact the future water supply, threatening the health of thousands of people in Monmouth and Ocean Counties. (It should be noted that the State of New Jersey intends to discontinue over 20 sources of contamination along the Manasquan River as part of its program to begin the construction of the proposed reservoir.)

The second concern, the impact of the site on the local environment, is both a public health and environmental issue. Terrestrial and aquatic flora and fauna appear to have been adversely affected at and adjacent to the site. In addition, downstream portions of the Manasquan River are stocked with trout which may be consumed by humans.

Based upon the results of the field investigation and the feasibility study, the potential impact of Lone Pine Landfill on the adjacent environment, and the potential contamination of the proposed reservoir, it was determined that the no-action alternative does not adequately protect public health and the environment and that a remedial measure should be implemented.

From the evaluation of existing data and information on the nature and the extent of the contamination associated with the Lone Pine Landfill, the following objectives were established:

1) To maintain an adequate safe drinking water supply for the population that could be affected by groundwater contamination migration;

2) To protect the Manasquan River surface water uses (fishing, swimming and water supply) from contaminant release; and

3) To prevent local exposure to contaminated materials at the site and in adjacent areas (soil, sediment, and leachate).

Although groundwater cleanup is also an objective, this issue will be addressed later with a separate Record of Decision.

With these objectives in mind, a list of feasible remedial measures was developed. Alternatives identified as having the potential to meet the remedial response objectives were subjected to a two-step evaluation process. The first step consisted of an initial screening of the candidate alternatives (see Table 10) based upon relative present worth cost, environmental impacts, and engineering considerations. The second step consisted of a more thorough evaluation.

Since the landfill's source strength and composition is largely unknown, the contaminant transport model used to simulate the relative contaminant transport for the remedial alternatives was calibrated to achieve the best fit to observed contaminant plume data. Various remedial schemes were simulated and evaluated by projecting the contaminant loading rates to the Manasquan River. (Field sampling results indicate significantly lower concentrations in the surface water than is predicted by the model since volatilization was not considered in the groundwater contaminant transport model). Because of the limited available data on the quantity and nature of the waste in the landfill and since the potential for contamination to continue to be released from the landfill exists, to ensure a conservative design a constant source strength was assumed for modeling purposes. It was also assumed that the wastes are evenly distributed over the landfill and capable of sustained, steady state releases. It should be noted that the purpose of the contaminant transport modeling was only to help evaluate the relative effectiveness of each alternative, the remedial alternative analysis and selection was based upon the groundwater flow model, which evaluated the effects of various containment and pumping schemes on the flow of groundwater in the underlying aquifers.

As a result of the initial screening, Alternative 2, the surface cap alternative, was deleted from further consideration. This

alternative allows the contamination to be released from the landfill, but at a reduced rate.

Based upon the available data and field observations, it appears that no significant groundwater mound (attributable to infiltration) exists within the landfill nor does it appear that the water level in the landfill substantially impacts the area groundwater flow, but rather the water encountered in the landfill is infiltrated water perched on top of local impermeable layers (such as impervious sludge zones). While infiltration may occur at the landfill surface, a major portion is believed to be diverted to surface seeps, never entering the Vincentown aquifer. Thus, the net infiltration to the saturated zone of the Vincentown within the landfill is estimated to be no greater than that to the undisturbed portion of the Vincentown Sands. These assumptions are supported by field observations indicating that seeps are intermittent and occur at various elevations and contain apparently different contaminants based upon staining color. Furthermore, no water was encountered in one of the trenches excavated for drum sampling. A relatively low mound beneath the landfill in the Vincentown aquifer does occur, but it is believed to be due to upgradient flows and surrounding surface controls rather than infiltration.

The hydraulic impact of the installation of a surface cap (10^{-7} cm/sec) alone was simulated under the conservative assumption that all of the infiltrated water recharged the Vincentown Sands aquifer and was reduced from about 0.1 cfs to 0.01 cfs or by 90% by the Cap. However, as it was stated above, only a small portion of the infiltrated water is believed to actively enter the Vincentown aquifer, with the majority being diverted to surface seeps. (Once the landfill is capped, all of the rainwater that infiltrates the cap that does not become perched, will eventually reach the underlying aquifer, since the surface seeps will have been eliminated.) The simulation of the installation of a cap resulted in a lowering of the water table by approximately 1 foot, corresponding to a reduction in the lateral groundwater flow beneath the landfill from 0.03 - 0.04 cfs to about 0.01 cfs. Over the area of the landfill, this represents an average decrease in the saturated thickness of the Vincentown Sand layer of approximately 10% with less than a 2% change in the thickness of the unsaturated zone. However, there is evidence that the site was excavated down to depths of 10 feet into the Vincentown sands aquifer during the period in which the landfill was being constructed and operated. Measurements from monitoring wells around the site indicate that the groundwater surface is above this level, allowing the lateral flow component of groundwater at the lower depths of the landfill, to flood the bottom of the fill area, potentially allowing the solubilization and dispersion of substances derived from ruptured drums and from bulk liquid dumping.

In addition, the strata underlying the landfill is complex and not fully understood. The planned installation of monitoring wells into the landfill mound will help provide further information relative to the level of water in the mound and help to better describe the subsurface strata. The potential problems are compounded by the uncontrolled manner in which disposal took place, resulting in the possibility that solvents could mobilize chlorinated organics which might otherwise tightly adsorb onto soil particles. Several non-volatile organic substances detected in the excavated drums (see Table 7), pose a cancer risk in drinking water at very low concentrations. Some of these constituents and their respective exposure levels based upon UCR values include Benzo (a) Pyrene (0.00304 ppb), Aldrin (0.00306 ppb), DDT (0.00416 ppb), Heptachlor (0.0104 ppb), and PCBs (0.00806 ppb). Although some of these substances were only found in trace amounts, the limited excavation and sampling program presents the possibility that significant quantities of these substances could be in the landfill. Therefore, the evidence shows that the reduction in infiltration resulting from the installation of a surface cap alone willnot eliminate the contaminant flux from the landfill to the groundwater.

The PRPs have expressed an interest in implementing Alternative 2 with a contingency plan should the monitoring program show that capping alone is ineffective in controlling releases from the landfill. However, as was indicated, the evidence does not support the PRP's conclusion that a cap alone would effectively prevent future releases to the environment. In addition, if this landfill had been a permitted hazardous waste disposal facility, closure in compliance with RCRA would be required which would entail a cap and a liner. Also, the State of New Jersey has specifically stated that a cap alone is inadequate and unacceptable.

Alternative 5, the deep slurry wall, was deleted form further consideration because it would cost about $9 M more than a shallow wall, while yielding only a slight groundwater cleanup advantage. In addition, this alternative presents technological difficulties in that the required depth of excavation is just about at the limits of available technology. Unlike the shallow containment wall system, the deep wall will entrap existing contaminated groundwater which is currently present in the Red Bank aquifer immediately below the site, removing it from the active flow field. An analysis of alternatives for groundwater cleanup will be conducted in the future and will address off-site groundwater contamination. If groundwater cleanup is recommended, then pumping and treating the off-site contaminated groundwater will have a cost considerably lower than $9 M.

Alternative 6 consists of the complete drum excavation and removal along with disposal of contaminated soil. This alternative was deleted from further consideration because it was not considered cost-effective and because the potential safety and engineering problems associated with drum excavation far outweighed the

long-term benefits. The cost estimate for complete drum removal is at least $80 M. The major safety concern results from a fire and explosion potential from the use of construction equipment, or spontaneous combustion, due to the presence of methane from the disposal of organics, including septage wastes. In addition, opening the landfill is likely to result in the release of odors associated with landfills undergoing anaerobic decomposition as well as the emission of volatile organic vapors from hazardous materials which in themselves are potentially harmful to public health. Excavation would subject on-site workers to the potential for direct contact with hazardous materials. Furthermore, the reliability of this alternative is questionable. It is likely that the majority of the buried drums have ruptured due to the high compressive forces and suspected corrosive environment in the fill area. (This is not to say, however, that the contents of the drums have necessarily left the landfill. Dispersion within the landfill is a function of many factors including the substance's density and the adsorptive and absorptive capacities of the soil and other solid materials disposed of in the landfill.) The materials that have leaked from the ruptured drums when added to the several million gallons of bulk liquid chemical wastes that were disposed of at the site yields a considerable quantity of waste that may not be removed with the excavated drums and the adjacent soil and waste material. So in short, it would be extremely difficult to identify all of the contaminated material and even a complete excavation of the drums and the adjacent soil and waste material may not necessarily remove the bulk of the contamination.

Table 10
Remedial Alternatives for the Lone Pine Landfill Site

1) No action with monitoring.

2) Surface cap (no containment).

3) Surface cap; containment by pumping contaminated groundwater (400 gpm); and treatment.

4) Containment by means of a surface cap and a slurry wall penetrating approximately 30 feet through the Vincentown aquifer to the Hornerstown formation, an aquitard; internal pumping (30 gpm) to maintain a negative internal gradient; and treatment.

5) Containment by means of a surface cap and a slurry wall penetrating approximately 140 feet through the Vincentown and Red Bank aquifers to the impermeable Navesink Marl; internal pumping (30 gpm); and treatment.

6) Drum excavation and removal; surface cap; interception (400 gpm) of contaminated groundwater; and treatment.

7) Containment by means of a surface cap and a 30-foot slurry wall; internal pumping (30 gpm) and flushing; and treatment of internal pumpage not used for flushing.

8) Containment by means of a surface cap and a 30-foot slurry wall; limited excavation (3 acre area of known drum disposal) of source materials; internal pumping (30 gpm) and flushing; and treatment of internal pumpage not used for flushing.

9) Containment by means of a surface cap and a 30-foot slurry wall; limited excavation of source materials; internal pumping (30 gpm); and treatment.

The flushing alternatives (7 & 8) consist of pumping contaminated ground water from below the landfill, treating it, and discharging it back on the landfill surface by spray irrigation or by subsurface injection with a piping or trench system. This concept is based on the use of relatively clean water to "flush" the contaminants from within the landfill mound with subsequent collection and treatment. This approach is intended to eventually lead to a removal of contaminants from the landfill. This alternative was determined to be technically infeasible because of the impermeable zones within the landfill, the likelihood for short-circuiting of the recharged water, and the hydraulic infeasibility of flushing in the northern and the northwestern portions of the landfill (where the bulk of the drums were allegedly disposed). In addition, the maintenance of the recovery wells will be difficult due to the high likelihood for clogging as a result of high iron concentrations. The wells will have to be cleaned and/or repaired frequently and a skilled operator will be required to carefully monitor the performance of the system. Thus, because of the significant operation and maintenance requirements, and since it is likely that flushing will have limited effectiveness in areas of known waste disposal, these options were deleted from further consideration.

After the completion of the initial screening of technologies, a further evaluation was conducted in order to recommend a cost-effective alternative. The following alternatives were developed for a more detailed analysis of effectiveness and cost measures.

Table 11
Alternatives Undergoing Final Evaluation

3) Surface cap; containment by pumping (400 gpm) of contaminated groundwater; and treatment.

4) Containment by means of a surface cap and a slurry wall penetrating approximately 30 feet through the Vincentown aquifer to the Hornerstown formation; internal pumping (30 gpm); and treatment.

9) Containment by means of a surface cap and a 30-foot slurry wall; limited excavation of source materials; internal pumping (30 gpm); and treatment.

This narrowed list of remedial alternatives was further evaluated according to the following criteria: cost, reliability, implementability, operation and maintenance requirements, environmental impacts, and safety requirements.

According to the NCP, a total cost estimate must also be considered for remedial actions and must include both construction and annual operation and maintenance costs. These costs were estimated for the alternatives under consideration. A present worth value analysis was used to convert the annual operation and maintenance costs to an equivalent single value. These costs were considered over a 20 year period at a 10 percent discount rate.

Alternative 3: Surface cap; containment by pumping (400 gpm) contaminated groundwater; and treatment.

This alternative differs from the slurry wall alternatives in that no physical on-site containment is provided, but rather a groundwater flow pumping system is used to collect contaminated groundwater before it enters the river. This interception system is composed of a series of off-site wells with a relatively high pumping rate. The wells are located in a zone between the landfill and the river since existing data indicate that flow is toward the river.

Simulation results indicate that this scheme will allow for partial treatment of the existing plume. The extraction wells provide a mechanism for capturing contaminants prior to their reaching the Manasquan River and continuous pumping will be required until the source is dissipated. Complete aquifer restoration could not be achieved until the source contaminants have ceased to migrate from the landfill, which is estimated to take more than 20 years. This alternative is capable of meeting the response objectives, is technically feasible and has a net positive impact on the environment, however, the lack of a containment wall implies greater adverse consequences to water quality if the pumps and treatment system should fail to perform properly in the future. In addition, the high pumping rate significantly affects operation and maintenance requirements and cost.

Alternative 4: Containment by means of a surface cap and a slurry wall penetrating approximately 30 feet through the Vincentown aquifer to the Hornerstown formation; internal pumping (30 gpm); and treatment.

Simulation results indicate that internal pumping within the Vincentown aquifer at 30 gpm will create a negative pressure gradient within the confines of the shallow slurry wall (similar to a sump pump), restricting the movement of contaminated groundwater away from the site. This will cause the groundwater to flow inward through the slurry wall and upward through the Hornerstown formation, effectively containing the source of contamination.

This alternative allows the migration of contaminants already in the Red Bank formation beneath the landfill to continue, pending resolution of the appropriate action for groundwater cleanup.

This alternative is technologically feasible, is capable of meeting the response objectives and is effective from an environmental standpoint. And because of the low pumping rate, associated operation and maintenance requirements will be considerably less than Alternative 3. In terms of non-cost and cost ranking, this alternative appears to be the cost-effective and environmentally sound choice for source control at this site.

Alternative 9: Containment by means of a surface cap and a slurry wall penetrating approximately 30 feet through the Vincentown aquifer to the Hornerstown formation; internal pumping (30 gpm); limited excavation of source material; and treatment.

This alternative is the same as alternative 4 but with the addition of a limited excavation of source material prior to containing the site.

Total excavation was previously discussed and eliminated from further consideration due to health, safety, and technical considerations. This alternative consists of a limited excavation program in an area of suspected high concentration drum disposal.

The proposed limited excavation is based on previous subsurface investigations at the landfill. These investigations included both a geophysical survey which identified magnetic anomalies within the landfill and a limited subsurface exploration program which investigated the presence of buried drums. The results of these programs were applied to evaluate the magnitude and extent of the proposed excavation.

The limited excavation program was assumed to include three acres where buried drums were previously found. The results of the earlier field excavation program were utilized to develop assumptions regarding the number of drums which would be encountered and the quantities of hazardous waste which require either on-site treatment or off-site disposal. Based upon assumptions regarding the locations and contents of the drums derived from the previous excavation activities, it was estimated that 7,700 drums could be recovered and approximately 45,000 cubic yards of contaminated soil and refuse would be handled as bulk hazardous waste.

Opening the landfill will likely result in adverse impacts on air quality from the release of odors and the emission of hazardous organic vapors which are potentially harmful to public health. On-site workers will be subjected to risks from direct contact with the excavated materials. In addition, workers will be subjected to dangers from fire and explosion.

Although the excavated drums and surrounding contaminated soil will be removed, a large area of the remaining landfill will still contain soil contaminated by the disposal of bulk liquid wastes or by the contents of ruptured drums.

Since the distribution of the contamination is largely unknown, there is no assurrance that this limited excavation will remove a significant portion of the total quantity of waste within the landfill. Therefore, the site will still need to be contained as in Alternative 4, offering about the same level of protection to public health and the environment as containment alone, but adding over $20 million to the cost.

Table 12 shows the various costs associated with the alternatives considered in the final screening.

Table 12
Present Worth
Remedial Alternative Costs Comparison ($ million)
for a Twenty Year Period

Alternative	Capital	O&M		Total Present Worth
3	13.2	12.9	(0.79)*	26.1
4	10.7	6.47	(0.32)	17.1
9	30.9	6.47	(0.32)	32.4

*(annual O&M)

As part of the Lone Pine Landfill remedial program, it will be necessary to treat the extracted contaminated groundwater. A treatability study has been initiated to identify treatment methods and preliminary operating parameters for an on-site treatment scheme, as well as an evaluation of discharging the contaminated water to a main trunk line sewer of the Ocean County Utilities Authority wastewater treatment plant. The potential discharge points for an on-site plant include the Manasquan River to the north of the site, and the Metedeconk River to the south. The results of this treatability study will be incorporated into the project design.

The treatment costs in Table 12 assume on-site treatment of the extracted groundwater. Table 13 shows the capital and operating costs for the on-site and off-site treatment schemes under consideration. Option 1 employs the construction of a force main through the woods along the river for a distance of approximately one mile to intersect with the main trunk line sewer. Option 2 employs the construction of a 4.5 mile force main along a roadway right-of-way to the main trunk line.

Table 13

Comparison of Capital and Annual Costs for
On-site and Off-site Groundwater Treatment ($ million)

	Alternative		
	3	4	9
On-site Treatment System Capital Cost	2.19	0.92	0.92
On-site Treatment System Annual Operation Maintenance Cost	0.67	0.23	0.23
OCUA Annual Charge	0.52	0.19	0.19
Option 1: 1 Mile Force Main	0.26	0.21	0.21
Option 2: 4.5 Mile Force Main	1.16	0.90	0.90

Community Relations

Throughout the feasibility study and the associated field work, all sampling data and reports have been submitted to the Freehold Township Health Officer who maintains a public repository and is the Chairman of the Freehold Township Technical Review Committee (TRC), a group of local residents and health officials appointed by the Mayor to review all technical documents associated with this project.

After publically releasing the draft Feasiblity Study, a three week public comment period ended on June 24, 1983, the date of the public meeting to discuss the findings of this document. The meeting was announced via a press release (see Attachment 1) which identified three public repositories as well as the location of the public meeting -- Freehold Township Administration Building, Freehold, New Jersey. This meeting was attended by 80 people consisting of EPA, NJDEP, TRC, several citizen groups, the local Congressional Representative, and local residents. Attachment 2 is a list of attendees.

As a result of comments offered by the TRC at several meetings, two additional alternatives were evaluated, which led to the development of the Supplemental Feasibility Study. This document was released to the public for comment on June 27, 1984, and a public meeting was held on August 1, 1984.

The date of the public meeting to discuss the findings of the Supplemental Feasibility Study with the public, was announced via a press release (see Attachment 3). The press release indicated the location of the meeting which was attended by 100 people. Attachment 4 is a list of attendees.

At the public meetings, as well as the TRC meetings, concerns were raised regarding containing the waste on-site. It is the community's preference to have all of the 45-acre landfill excavated and taken away. It is their belief that as long as the source of contamination remains, the Township could be adversely affected. It has been requested by the community that EPA perform a research and development investigation at the site to evaluate innovative decontamination techniques.

Attachment 5 is a responsiveness summary which summarizes the comments on the feasibility study, the public meetings, the meetings with the TRC, and comments from the Generators Steering Committee.

Consistent with Other Environmental Laws

The selected remedial alternative complies with all substantive requirements of RCRA, the Clean Water Act, and the Clean Air Act.

Recommended Alternative

According to 40 CFR part 300.68 (j), cost-effectiveness is described as the lowest cost alternative that is technically feasible and reliable and which effectively mitigates and minimizes damage to and provides adequate protection of public health, welfare, and the environment. Nine alternatives were evaluated. The no action alternative was found to provide inadequate protection of public health and the environment. Surface capping with no containment was also found to provide an inadequate level of protection because of the continuing potential for groundwater contamination. This potential results from the existence of a shallow surficial groundwater aquifer and evidence that wastes were buried beneath the water table. Moreover, rupturing drums are likely to release liquids in the future which would migrate into the groundwater. This risk is enhanced by sampling results which show the presence of solvents in addition to chlorinated organics, some of which are suspected carcinogens at very low concentrations in drinking water, which might otherwise have a tight affinity for soils. A cap with high rate groundwater interception by pumping would be feasible as would containment by a slurry wall. A shallow slurry wall (30 feet) was found to have the same level of reliability as a deep slurry wall (140 feet). Site excavation and flushing alternatives were also considered. Complete excavation of the 45 acre site with disposal of contaminated waste and soil was found to be impractical and dangerous. Flushing was found to be not feasible because of potential operational and reliability problems.

Table 12 shows the present worth costs for the most feasible alternatives which include containment by high rate pumping (3); containment by a shallow slurry wall (4); and shallow slurry wall containment and limited excavation (9).

The limited excavation alternative has the highest present worth cost at $37.4 million. Because of the uncontrolled and random nature of dumping at the site, it is not possible to assume that the limited excavation will remove even as much as half of the waste from the site. Therefore, the same capping and containment measures are necessary as would be required without the excavation. The extra cost for this alternative and the additional health and safety risks do not result in additional reliability in terms of reduced release to the environment.

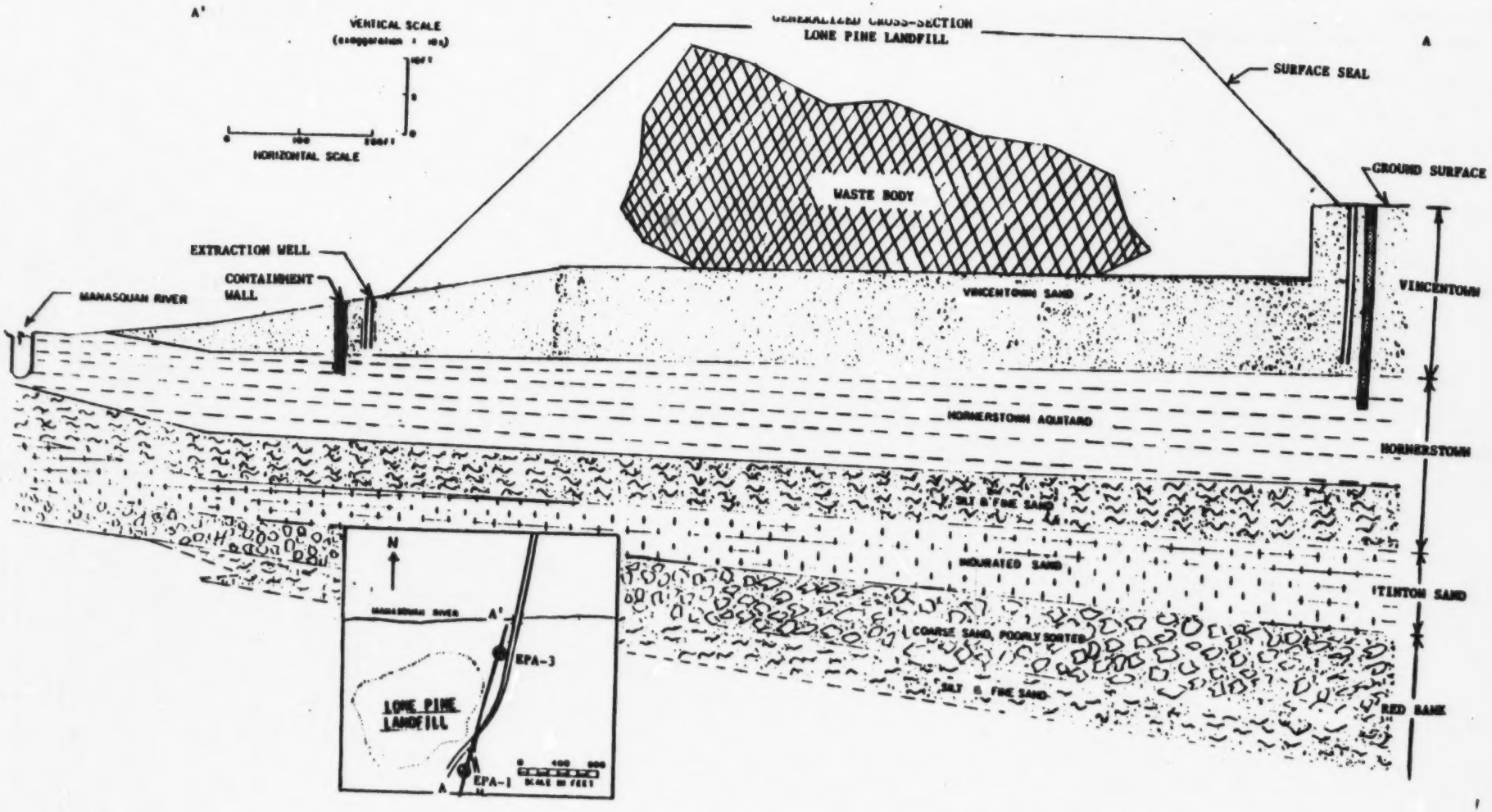
Containment by high rate pumping has a present worth of $26.1 million and the slurry wall alternative has a present worth of $17.1 million. The reason for the large difference is associated with the capital cost and the cost for long-term water treatment at a pumping rate of 400 gpm versus 30 gpm. However, an important advantage of the larger pumping rate is that it will also result in cleanup of some existing groundwater contamination. Preliminary simulation results from the feasibility study suggest that the off-site contaminated plume could be recovered at a lower pumping rate of 200 gpm (if a slurry wall is in place) for a present worth cost of about $8 million. Thus, even if an off-site groundwater cleanup program were initiated in the future along with the shallow slurry wall alternative, the combined present worth cost ($25.3 million) would be less than the cost for plume interception at the high pumping rate of 400 gpm. In addition, the slurry wall will provide more reliable containment and the off-site plume cleanup could be accomplished in about 20 years. Because of the uncontained source, high rate pumping is likely to continue well beyond 20 years. Therefore, capping with a shallow slurry wall is the cost-effective alternative for this site.

The recommended alternative (see Figure 8), consists of the following on-site and off-site activities:

On-site:

o groundwater cut-off wall

On-site containment will be provided through the use of a shallow groundwater cut-off wall penetrating approximately 30 feet through the Vincentown aquifer and keying into the Hornerstown formation, an aquitard. The wall will ring the landfill's perimeter for a distance of about 6000 feet, enclosing approximately 45 acres. The groundwater cut-off wall will be installed to achieve a maximum permeability of 1.0×10^{-7} cm/sec.



PROPOSED REMEDIAL SOLUTION: SURFACE CAP, CONTAINMENT WALL, AND PUMPING AND TREATMENT

Figure 8

o surface seal

To reduce rainwater infiltration and gas release, the landfill mound will be covered by a multi-layer surface sealing system as follows: A 1-foot layer of fill will be used to grade the existing local fill cover. This layer will be covered with a 1-foot thick layer of clay (permeability not to exceed 1.0×10^{-7} cm/sec), a 1-foot thick layer of fine fill and a 6-inch layer of topsoil. The topsoil will be seeded to stabilize the surface. The cap will comply with requirements under RCRA.

o internal wellfield

Because the downward flow of contaminants from the Vincentown aquifer into the Red Bank aquifer must be checked, an internal pumping system (30 gpm) consisting of a series of six wells, is included to produce a negative, inward gradient similar to a sump pump, to relieve the hydraulic escape of contaminants through the Hornerstown formation, an aquitard. This internal pumping system will also remove any water that has infiltrated the surface seal or the groundwater cut-off walls.

o treatment system

The contaminated groundwater extracted from the wellfield inside the groundwater cut-off wall will be treated or pretreated, as necessary, and tested prior to discharge to the Manasquan or Metedeconk River or the Ocean County wastewater treatment plant interceptor. An on-site physical/chemical treatment scheme would address the contaminated groundwater as it is received rather than being designed for anticipated contamination levels since the source strength is unknown and the nature of the contamination may change over time. The specific treatment system will be designated upon completion of the ongoing pilot plant and bench scale treatability studies.

If on-site treatment is selected, the treatment plant effluent would be discharged to a 1-day storage tank to allow sampling and testing prior to discharge to the Manasquan or Metedeconk River in accordance with NJPDES. If the Ocean County wastewater treatment plant is utilized as the treatment mechanism, it is likely that a force main will be utilized to convey the waste to the interceptor located in the vicinity of the site. The ongoing treatability studies will assure the compatability of the contaminated groundwater to the proposed treatment system.

o monitoring program

Six nested observation wells, screened above and below the Hornerstown formation would be used to monitor the effectiveness of the remedy and to facilitate determination of seasonal optimum pumping rates at each location.

o surficial cleanup

A surficial drum and debris cleanup at the adjacent borrow pit area will be performed during remedial implementation. This material will be disposed of on the landfill before capping, since it is believed that these drums are empty.

o site securing

The existing fencing restricts vehicular and pedestrian traffic from Burke Road. The entire site will be enclosed to exclude to the extent possible wildlife, hunters, and dirt bikers.

Off-site:

o limited groundwater sampling and monitoring program

The need to implement an on-site containment measure to prevent any future releases of persistent hazardous compounds from the landfill has been established by evaluating the available data. Because of the questions raised about the contaminant flow path By recent sampling results at this site, additional off-site groundwater sampling will be performed to better define the extent of the contaminant plume emanating from the landfill and to define the need for off-site plume control.

Cost summary for recommended remedial alternative 4

The following table represents a cost estimate for the proposed remedial actions. Cost sharing for the off-site field investigation and design portion is 100% EPA-financed. Cost sharing for construction is 90% EPA and 10% State. The actual requested amount for the off-site field investigation, design, and construction phase of this project is $11.2 million. As a result of consideration of credit given to the State by EPA, the State's share of the capital cost is reduced by $33,000.

Table 14
Selected Remedial Alternative Capital Costs

Activty	Costs
Cap and Surface Cleanup	$ 5,690,000
Shallow Containment Wall	882,000
Internal Wellfield	210,000
Treatment System*	921,000
Storage	150,000
Monitoring Program	30,000
Engineering and Contingencies (35%)	2,759,050
Total Capital Cost (EPA share $9,610,845. state share: $1,031,205)	$10,642,050
Preparation of Detailed Design	$1,060,000
U.S. Army Corps of Engineers Service During Design and Construction	532,103
Additional Off-Site Field Investigation	100,000
Total Funds Required (EPA share: $11,302,948, state share: $1,031,205)	$12,334,153

* The actual costs associated with the groundwater treatment facility will be determined upon completion of the ongoing treatability studies. The more conservative on-site treatment system was used for costing purposes.

Operation and Maintenance

o monitoring

As part of the remedial action, a water and air sampling program, which is consistant with State permit requirements, is included to monitor changes in the nature and extent of contamination at the site to determine the effectiveness of the operation. The water sampling plan will be modified as necessary upon completion of the planned hydrogeological investigation.

Groundwater sampling in both the Vincentown and Red Bank formations will consist of sampling from two pairs of nested monitoring wells. Surface water samples will be collected at two Manasquan River locations. Ground and surface water samples will be analyzed for priority and non-priority pollutants semi-annually for the first 2 years and annually, thereafter, if the rate of contamination decreases. In addition, if an on-site treatment plant is constructed, as long as the plant is in operation, the plant's effluent would be sampled daily for total organic carbon and total organic halides and weekly for volatile organics.

Following the installation of the surface seal, total hydrocarbons monitoring (and meteorological data collection) would be repeated for 2 months to test the effectiveness of the surface seal. Four gas monitoring wells will be installed and sampled for methane quarterly for the first 5 years, and semi-annually thereafter, if no methane problems are determined to exist. Sampling for priority pollutants would be conducted quarterly for the first 3 years and semi-annually, thereafter, if contaminant levels are acceptably low.

o operation and maintenance

The remedial measures proposed for the Lone Pine Landfill have operation and maintenance requirements to protect the integrity of the remedy.

To maintain a negative internal gradient at the site, a series of six extraction wells will be required. These will be located within the boundary of the slurry wall, but outside of the fill area, and extending an average depth of 30 feet below grade. These wells will extract approximately 30 gpm. The high natural iron content in the groundwater may result in fouling of the groundwater extraction wells and screens by iron-oxidizing bacteria. A cleanup frequency of once per 6 months and a replacement frequency of once every 2 years is anticipated to maintain the effectiveness of the groundwater extraction system.

The 30 gpm of highly contaminated groundwater extracted to maintain the negative gradient within the landfill will have to be treated. A treatability study is currently being conducted to identify feasible on-site treatment methods as well as an evaluation of discharging the contaminated groundwater to the Ocean County Utilities Authority (OCUA) wastewater treatment plant. In either instance, routine operation and maintenance will be required to maintain the integrity of the remedy. An on-site system would most likely include a combination of unit processes, the operation and maintenance of which will be required. Sludge generated in this treatment process will have to be dealt with regardless of whether it is hazardous or not. If the OCUA is utilized to treat the extracted contaminated groundwater, the force main, as well as the pump station and the associated appurtenances, will have to be maintained.

The landfill mound will be covered by a multiple-layer, grass-covered surface system which would also include provisions for drainage swales to transport rainwater away from the landfill. Repairs of subsidence, erosion, and burrowing by animals, as well as grass mowing, will be required to maintain the integrity of the surface sealing system.

The 6000 linear-foot slurry wall encircling the site will require periodic testing to ensure its structural integrity. A gas control system consisting of a series of gas monitoring wells will be provided and will have to be maintained.

The annual operation and maintenance requirements for the recommended remedial measure are as follows:

Table 15
Annual Operation and Maintenance Costs
for Selected Remedial Alternative

Item	Annual Cost (20 years)
Internal Wells	$3,234
Surface Seal	5,000
Groundwater treatment	228,000*
Storage	750
Subsurface monitoring program	87,850
Total	$324,734

* or $196,750 if the OCUA wastewater treatment plant is utilized

It is the Region's recommendation that EPA finance the operation and maintenance for a period not to exceed one year.

Schedule

Table 16
Remedial Alternative Implementation Schedule

Activity	Date
-Complete Enforcement Negotiations	September 21, 1984
-Final Record of Decision	September 21, 1984
-Amend State Superfund Contract for Design	September 28, 1984
-Award IAG for Design	September 28, 1984
-Begin Design	November 1, 1984
-Complete Design	May 1, 1985
-Amend State Superfund Contract for Construction	June 1, 1985
-Award IAG for Construction	June 1, 1985
-Begin Construction	July 1, 1985
-Complete Construction	July 1, 1987

Future Actions

o field investigation

Because of the uncertainties regarding the extent of the off-site contamination developed as a result of the recent round of monitoring well sampling, additional off-site hydrogeological investigative work will be necessary. This will include the placement of four monitoring wells to the north of the Manasquan River, two monitoring wells south of the river, and the resampling of selected existing monitoring wells. This work is tentatively schedueled to begin in late October 1984.